PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

Public University of Navarre

SCHOOL OF AGRICULTURAL ENGINEERING

Agri-food & Rural Environment Engineering

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

March 2018

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Abstract

The objective of this project is to design the process system of a canned asparagus and pepper industry. The project is located on plot 270 of industrial park 2, Lodosa, Navarre. The total production of the company will be 770 tons, 470 of which will be destined to canned pepper and 300 will be destinated to the production of canned asparagus. Within the production of pepper, 150 tons are destined to the production of piquillo peppers Appellation of Origin ”Pimiento del Piquillo de Lodosa” and within the production of asparagus, 100 tons are destined to the production of asparagus, Specific Appellation “Espárrago de Navarra”. There are also calculated the refrigeration and piping installations of the industry.

Key words: Food industry, canned industry, Appellation of Origin Pimiento del Piquillo de Lodosa, Specific Appellation Espárrago de Navarra, canned vegetable.

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PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

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DOCUMENT 1. REPORT

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1. Object

The aim of this project is to design the process system of a canned vegetables industry that is initially dedicated to the production of canned asparagus and peppers. One part of the pepper production is covered by the certified Appellation of Origin "Pimiento del Piquillo de Lodosa". Furthermore, one part of the asparagus production is covered by the certified Specific Appellation "Espárrago de Navarra".

The initial production of the industry will be 770 tons, of which 470 tons will be dedicated to the production of canned peppers (150 tons covered by the Appellation of Origin and 320 tons of piquillo variety), 300 tons of asparagus production (100 tons covered by the Specific Appellation and 200 tons of white asparagus). The project is located in Lodosa, Navarra.

2. Scope

The project scope includes the design of the process technology and process engineering in order to produce canned pepper and asparagus. Not only covers these designs, but also the planning of the production, the industry distribution layout and the design of the piping and refrigeration installations. In addition, a market and financial feasibility study will be carried out.

For this purpose, a study of alternatives will be carried out so that the most appropriate one is chosen for each aspect of the industry.

It is not included in the scope the design of other installations not mentioned above nor of the construction of the building. Own-entity studies such as the environmental impact study or the safety and health study will not be included either.

3. Background

This project entitled "Process system design of a canned vegetables industry" has been drafted with the aim of be able to pass the course 2017_0_501890_1 Trabajo Fin de Grado, and thus get the title of Graduate in Agri-food & Rural Environment Engineering by the Public University of Navarre.

The initial conditions of the project consist on the selected plot, in which the building is already built, needing only the calculation of the process system, the design of the distribution layout and the piping and refrigeration installations.

4. Standards and references

4.1. Legal provisions and applied rules

UNE 157001: 2014, General criteria for the formal preparation of the documents constituting a technical Project

Decree 2484/1967, of September 21, by which the text of the Spanish Food Code is approved.

Order of July 13, 1993 by which the Specific Appellation "Espárrago de Navarra" and its Regulatory Council is approved.

Order of May 8, 1987 by which is ratified the regulation of the Origin Appellation (Pimiento del Piquillo de Lodosa) and its Regulatory Council.

Order of September 22, 1973 about the normalization of the canned vegetables.

Royal Decree 2420/1976, of June 2, whereby is approved the technical-sanitary regulation for the elaboration and selling of canned vegetables.

Royal Decree 1808/1991 of December 13, which regulates the mentions or brands that allow identifying the batch to which a food product belongs.

Royal Decree 1334/1999 of July 31, whereby is approved the General Norm of labelling, presentation and advertising of food products.

Resolution of August 1, 1979 approving the positive list of authorized additives in the production of canned and semi-canned vegetables.

Order of June 21, 1983 on characteristics and formats of canned vegetable containers, vegetable juices and derivatives and prepared (cooked) dishes sterilized.

Royal Decree 140/2003, of February 7, whereby are stablished the sanitary criteria of the human consumption water quality.

Royal Decree 138/2011, of February 4 whereby the Safety Regulations for refrigeration installations and their complementary technical instructions are approved.

Normative EN15154-1-2, European standard for emergency showers.

Regulation (EC) 852/2004 of the European Parliament and the Council of April 29, 2004.

Royal Decree 946/2003 of July 18, which establishes specific labelling requirements for canned white asparagus.

Royal Decree 486/1997, of April 14, which establishes the minimum safety and health provisions in workplaces.

4.2. Softwares

- AutoCAD 2016®
- Microsoft Word 2016®
- Microsoft Excel 2016®
- Microsoft Project 2010®
- BP Frío, versión 2.1.1. [Computer program of refrigeration installation calcullus]. Valencia. Universidad Politécnica de Valencia (UPV).

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5. Definitions and abbreviations

5.1. Definitions

Food: "Food" means any substance, processed, semi-processed or raw, that is intended for human consumption, including beverages, chewing gum and any other substances that are used in the manufacture, preparation or treatment of food, but not includes cosmetics or tobacco or substances used only as medicines.

Food additive: "Food additive" means any substance that by itself is not normally consumed as a food, nor is it used as a basic ingredient in food, whether or not it has nutritional value, and whose addition to the food in its production phases, manufacture, processing, preparation, treatment, packaging, transport or storage, result (or can reasonably be expected) directly or indirectly by itself or its by-products, a component of the food or affect its characteristics. This definition does not include "contaminants" or substances added to the food to maintain or improve the nutritional qualities.

Labelling: Refers to any printed or graphic material present on the label, which accompanies the food or that is displayed in proximity to it, including that which has the purpose of promoting its sale or placement.

Ingredient: It is any substance, including food additives, that is used in the manufacture or preparation of a food and is present in the final product, although possibly in modified form.

Canned vegetable:

- Prepared from fresh, healthy vegetables (with the exception of mature peas processed), frozen, and that they have reached an adequate degree of maturity for their elaboration. They must be washed and prepared correctly, according to the product to be elaborated, but without eliminating any of its essential elements. Depending on the type of product to be processed, they can be washed, peeled, sorted (calibrated / sieved / sifted), cut, etc.
- Vacuum packaging with a covering liquid that does not exceed 20% of the net weight of the product and when the container is closed under conditions that generate internal pressure in accordance with good manufacturing practices.

Canned product: They are processed foods based on products of vegetable origin with or without the addition of other food and food substances allowed, subjected to authorized treatments that guarantee their conservation and contents in appropriate packs.

Semi-canned product: They are foods made from products of vegetable origin, with or without the addition of other food or food substances allowed, stabilized for a limited time by appropriate treatment and kept in suitable packs.

Commercial sterilization: Process by which all life forms of microorganisms capable of producing alterations in food under normal storage conditions are destroyed or inactivated for a determined period of time.

5.2. Abbreviations

- MAPAMA: Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente
- FAO: Food and Agricultural Organization of the United Nations
- NPV: Net Present Value
- IRR: Internal Rate of Return
- TSWV: Tomato Spotted Wilt Virus
- CMV: Cucumber Mosaic Virus
- PVY: Potato Virus Y
- SFC: Spanish Food Code

- DRT: Decimal Reduction Time
- P&ID: Piping and Instrumentation Diagram

6. Design requirements

In this case the promoter and project manager are the same person. The client is the owner of the plot that wants to dedicate itself to the food industry, elaborating canned products, initially of asparagus and pepper.

First, the essential requirements are the development of quality and safe products for final consumers.

Secondly, as it is a food industry there are certain industrial requirements that must be included:

- Installation of washing and selection of raw materials
- Installation of packaging and closure, with adequate capacity to the line or lines of manufacture that precede.
- Steam generator or other source of thermal energy.
- Specific facilities for semi-canned and canned vegetables by thermal treatments.
- In the case of sterilized food production, the sterilization facility will consist of: autoclaves for pressure sterilization of the products or another installation system that allows achieving industrial or technical sterilization. In the case of using autoclaves, these must be equipped with graphic recording equipment of temperatures and time.

In addition, as far as possible, the chosen equipment will be designed in such a way that washing them is simple. Taking into account that it is a food business and cross contamination should be avoided, another requirement that must be taken into account is the forward follow of the process.

Taking into account that on the facade of the product shipment is the reception of workers and customers, we will try to organize the schedules in such a way that trucks and people do not coincide and thus reduce the risk of accident.

7. Priority order of the documents

The priority order of the documents is the following one:

1. Drawings
2. Specification sheet
3. Measurements and budget
4. Report
5. Annexes

8. Location and siting

8.1. Project location

The present project is situated in the “Comunidad Foral de Navarra”, in the town of Lodosa. The industrial park selected is number 2, the chosen plot is number 270, located in sub-area 1, on “El Ramal” street at the corner with “Calderín” street. The graphic information about the location of the project is in *Drawing 1. Location* and in *Drawing 2. Siting*, located that belong to *Document 3. Drawings.*

Lodosa is a town located in the “Comunidad Foral de Navarra”, belonging to the municipality of Estella. It limits as the Town hall of Lodosa (2018) indicates to the north with the town of Sesma, to the east with Cárcar, to the south with Padrejón (La Rioja) and Ausejo (La Rioja), and to the west with Sesma and Alcanadre (La Rioja). Lodosa is located 75 kilometers southeast of Pamplona, the capital of Navarre.

Lodosa has advantages in terms of communication with another important capital of the autonomous community of Spain, with Zaragoza. From Lodosa, the AP 68 motorway is very accessible along the NA-232 national road to reach the Aragonese capital.

Lodosa is a town with an important economic activity related to agricultural production, its main crops are asparagus, tomato or piquillo peppers. This is due to its good infrastructure dedicated to these crops, in terms of rainfed and irrigated land and arable land. They have 892 hectares of irrigated land and 1954 hectares of rainfed. For this reason, it gathers the necessary resources to supply the industry with the needs of raw material and other elements that take place in the productive cycle.

Regarding the water resource, in food processing industries, water is one of the most important resources, this is one of the reasons why this location has been chosen for the project, since Lodosa is crossed and supplied by the river Ebro that crosses the town.

8.2. Climate and soil

This point in the project has been added in order to provide some information about the town where the project is located.

Lodosa presents a Mediterranean-continental climate, the dominant winds are those of the southwest, warm and humid, and those of northwest direction "cierzo". According to the climate classification of Thornthwaite, the climate type is semi-arid.

Regarding the geomorphology of the area, the materials that appear are mainly silt and clay, as well as limestone and gypsum. The softest slopes of the terrain appear on the lower terraces of the Ebro river, where the oldest and most productive irrigated fields are located.

8.3. Selection criteria concerning the terrain

Regarding the selected land, Navarra is not among the autonomous communities with the most expensive square meter in the country since it is below Madrid, Catalonia, the Balearic Islands and the Basque Country. One of the selection criteria related to the land chosen to locate a project are the neighbors, of which there are plots with industries dedicated to food, such as “Conservas Pedro Luís” or “EZMA-Food Processing Technology”. For more information about the location and siting of the project, it is recommended to see *Annex 1. Location and siting.*

9. Market study

9.1. Food industries

9.1.1. World level

Regarding the situation of the food industry, in Europe represents the largest activity of the manufacturing industry, having 14.6% of sales together with a value that exceeds the number of 1,244,000 million euros. Europe has around 289,000 companies that employ 4.29 million people, representing almost 50% of sales within the agricultural sector.

9.1.2. National level

In Spain, the food and drink industry is one of the most important sector representing the 20% of the product sales, more than 18% of the occupied people, 18% of the net investments in raw materials and 16% of the value added.

9.2. Canned vegetables industry

9.2.1. World level

The European market for canned fruits and vegetables production is the largest in the world, representing more than 40% of total importations. Import volumes of canned fruits and vegetables are stable. The main importation and consumption markets are Holland, Germany, France and the United Kingdom.

The main supplier of canned fruit and vegetables from developing countries is China (mainly canned tomatoes, mixed vegetables and asparagus), followed by Turkey (olives), Thailand (pineapples) and Peru (mostly asparagus).

The suppliers from developing countries with the most significant growth in exportations of canned fruits and vegetables to Europe in the last five years were Egypt (49% annual growth, mostly canned tomatoes), Chile (40%, mostly canned tomatoes, blueberries and grapes) and the Philippines (13%, canned pineapples).

9.2.2. National level

The sector of canned vegetables in Spain is characterized by the stability of volumes and operators, with a strong dependence on foreign markets. It is a mature market with a sale in 2016 of around 6220 million euros and 1.5 million tons of production. It is a well-structured sector that exports around 50% of the production in volume and around 40% of its total turnover. The main areas of canned food production in Spain are the area of Albacete, Alicante and Murcia. The area of Navarra, La Rioja and Aragon. The area of Valencia and Castellón. The area of Andalusia and Extremadura.

The Spanish sector of companies that manufacture and sell canned vegetables is made up of about 600 operators, although the lack of dynamism of intern demand is causing some small groups to leave the activity every year and the concentration tends to be more pronounced. Currently, the canned vegetable market tends to be dominated by large multinationals.

Table 1: Leading companies in the canned vegetables sector, (ALIMARKET, 2015)

PRINCIPALES EMPRESAS DEL SECTOR DE CONSERVAS VEGETALES	
EMPRESA	**VENTAS Mill. Euros**
Conservas El Cidacos, S.A. *	215,00
Hero España, S.A. *	200,20
Grupo Ángel Camacho, S.L. *	196,70
Grupo Ybarra Alimentación, S.L. (GYA) *	180,00
Grupo Helios *	164,00
Juver Alimentación, S.L. *	155,31
Coop. Alimentos del Mediterráneo *	145,00
H.J. Heinz Foods Spain, S.L. *	144,00
Compre y Compare, S.A. *	115,00
Industrias Alimentarias de Navarra, S.A.U. *	110,56

9.2.3. Consumption

According to the consumption of fruits and vegetables that have been transformed, in Spain the number of 592,7 million of kg consumed was achieved, also, 1,251 million of euros were spent in 2015. The most significant consumption is the canned vegetables products that was around 10,2 kg per person and year.

Table 2: Transformed fruit and vegetable consumption and spending in Spain, 2015, (ALIMARKET, 2015)

CONSUMO Y GASTO EN FRUTAS Y HORTALIZAS TRANSFORMADAS DE LOS HOGARES, 2015				
	CONSUMO		GASTO	
	TOTAL (Millones kilos)	*PER CÁPITA* (Kilos)	TOTAL (Millones euros)	*PER CÁPITA* (Euros)
TOTAL FRUTAS Y HORTALIZAS TRANSFORMADAS	**592,7**	**13,3**	**1.251,0**	**28,0**
FRUTAS Y HORTALIZAS EN CONSERVA	454,5	10,2	993,1	22,2
GUISANTES	9,4	0,2	21,4	0,5
JUDÍAS VERDES	11,9	0,3	17,0	0,4
PIMIENTOS	15,3	0,3	62,2	1,4
ESPÁRRAGOS	21,5	0,5	123,9	2,8
ALCACHOFAS	8,9	0,2	38,7	0,9
CHAMPIÑONES Y SETAS	18,1	0,4	50,3	1,1
MAÍZ DULCE	18,9	0,4	58,6	1,3
MENESTRA	4,6	0,1	8,2	0,2
TOMATES	241,2	5,4	319,3	7,2
TOMATE FRITO	172,2	3,9	239,6	5,4
TOMATE NATURAL	69,0	1,5	79,7	1,8
TOMATE NATURAL ENTERO	9,2	0,2	11,5	0,3
TOMATE NATURAL TRITURADO	59,8	1,3	68,2	1,5

9.2.4. Exportation and importation

It is considered that, in general terms, it is exported around 50% of the total volume produced, while in value its contribution exceeds 41%, with about 2900 million euros. Within the exportations stand out those of tomato, by a value of 322 million euros, in addition to canned mushrooms with 50600 tons and 75,4 million euros; of artichokes with 28400 tons and 52,2 million euros; and corn with 26300 tons and 33,6 million euros.

The destination countries of this foreign trade, are mainly European Union countries, in the case of canned products from Murcia, exportations have as main objective the United Kingdom and France with market shares of 22% of total exports.

9.3. Pepper

The origin of the pepper resides in South America, coming from the area of Bolivia and Peru. Currently, almost half of the world's pepper is produced in the Mediterranean area. It belongs to the group of vegetables that are produced in practically all parts of the world.

9.3.1. World level

The first pepper producing country in the world is China with 16,000,000 tons. Taking into account data from the Food and Agricultural Organization of the United Nations (FAO), pepper production has increased in production over the years in a constant way.

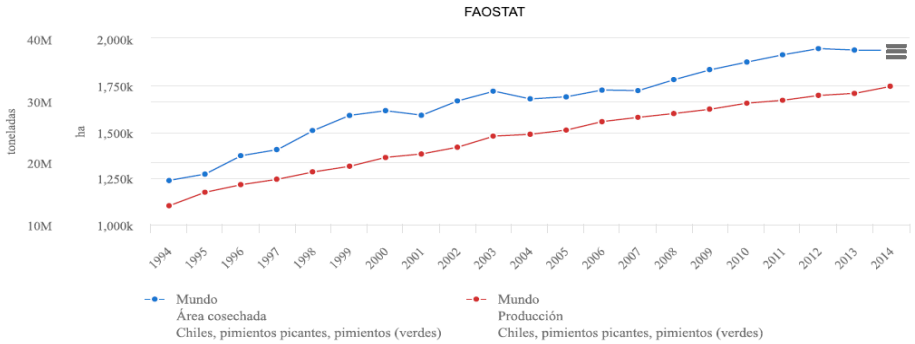


Figure 1: Pepper production data in the world, (FAO, 2014)

Regarding the pepper exportation, Mexico is one of the most important exporting country and its principal client is the US. There has been a boom in sweet bite peppers production with an integrated pest control of 20-25%.

Within the exportation frame of pepper, Spain has as clients Germany, France, Holland, United Kingdom and Italy. Considering this, Mexico is not considered as competence due to the fact that it has only one client, although it is a huge one. In Spain, Almería represents the 69,08% of exportations in the country, followed by Murcia that represents the 13,34%. Spain is also an important client for Morocco, followed by France and Germany that also buy pepper from the African country.

9.3.2. National level

Pepper is one of the most important products in Spain, as it has been commented above, the leading area in the country is Almería with a pepper production of more or less the 69%, followed by Murcia with the 13% of the state production. The production per square meter in Almería is about 8 kg, while the production per square meter in Murcia reaches the number of 11 kg.

9.4. Asparagus

The asparagus is a vegetable whose origin can be located in the Mediterranean basin as in Egypt appeared monuments with paintings in which bunches of buds with two or three ligatures. However, the first news about the crop itself is in the times of the Greeks.

9.4.1. World level

The leading country in terms of asparagus production is China since it produces more than 5 million tons, data provided by FAO. China is followed by Perú that produces less than 300 hundred thousand tons per year. The Spanish production is 57 thousand tons per year more or less, that is why it would be situated in the sixth place.

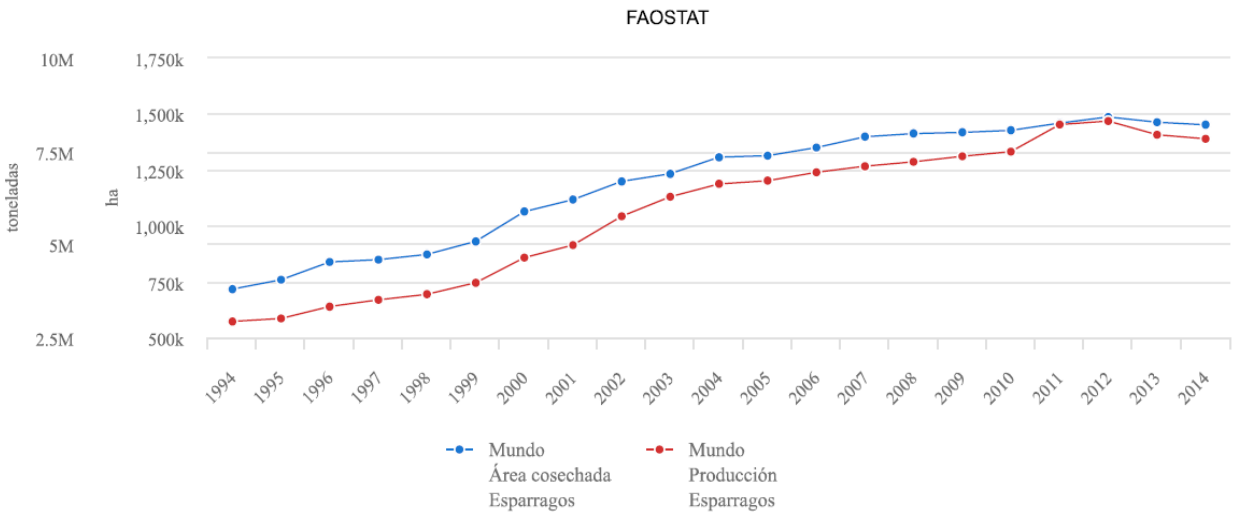


Figure 2: Asparagus production in the world, (FAO 2014)

Regarding the exportation, within the European Market, the principal importing countries of asparagus produced in outside European area are: Holland, Spain, United Kingdom and Germany. And the principal suppliers of asparagus produced in countries outside the European area are Perú, Hungary, South Africa and the US.

9.4.2. National level

Despite to the fact that Spain is one of the biggest asparagus producers, it imports product from Perú and China, that is why, by this way the price of the asparagus is way lower than the Spanish ones. This lower price because few reasons for instance the workforce salary. The following graph shows the production progress of asparagus in Spain.

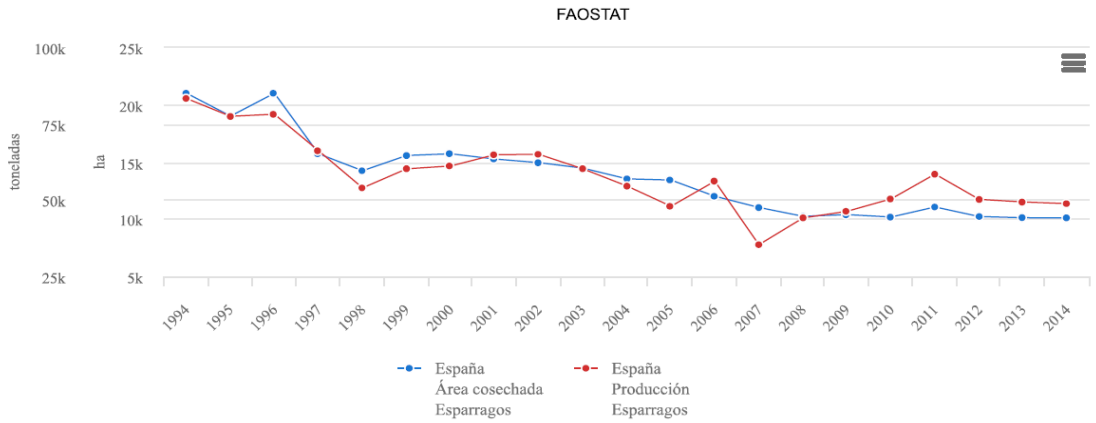


Figure 3: Asparagus production in Spain, (FAO, 2014)

In order to read more information about the market study, it is recommended to go to the *Annex 2. Market Study.*

10. Raw material analysis

The raw material analysis is divided in principal raw material and auxiliary raw material.

10.1. Principal raw material

10.1.1. Pepper

Regarding the origin of the pepper, all different species of *Capsicum* come from America. Depending on the variety the origin is one or the other. For example, the associated wild species, *Capsicum cardenasii* and *Capsicum eximium* grow in dry habitats in Bolivia and Argentina. The *Capsicum annuum* group that has white flowers, is associated with more humid habitats, it has been originally distributed through the tropical lowlands of South and Central America.

Regarding pepper taxonomy and morphology, it belongs to the family Solanaceae, the species *Capsicum annuum* L. The pepper plant is perennial and herbaceous with an annual growing cycle with different sizes reaching heights of 2 m.

Image 1: Capsicum annum white flower

Image 2: Pepper in plant

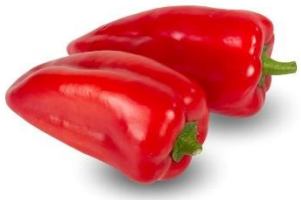


Image 3: Pepper fruit

In terms of pests, thrips, aphids, mites and caterpillars stand out. While the diseases that affect the peppers include fungal diseases of soil, aerial fungi. Finally, it is worth mentioning that the viral and bacterial diseases also affect the pepper culture.

Regarding the physicochemical aspects, the chemical composition of the pepper for each 100 g of product, in this case of the sweet pepper is the following:

- Dry matter (%): 8,0
- Energy (kcal): 26,0
- Protein (g): 1,3
- Fiber (g): 1,4
- Calcium (mg): 12,0
- Iron (mg): 0,9
- Carotenes (mg): 1,8
- Thiamine (mg): 0,07
- Riboflavin (mg): 0,08
- Niacin (mg): 0,8
- Vitamin C (mg): 103,0
- Average nutritive value (ANV): 6,61
- ANV per 100 g of dry matter: 82,6

Regarding the acidity of the product, the canned pepper products have a pH value between 3,8-4,5. Thus, it is applied citric acid to the canned product in order to make it little more acid so the final heat treatment does not have to be strong, needing a pasteurization.

Lastly, pepper can be characterized as partially climacteric product as the content in ethylene is double when the fruit turns from green to red. Nevertheless, the climacteric changes are not really pronounced as they are in other members belonging to the Solanaceae family. In order to get more information about the characteristics, pests and illnesses about pepper, it is highly recommended to go to the *Annex 3. Raw material analysis.*

10.1.2. Asparagus

Regarding the origin, the asparagus is one of the horticultural crops of those that have more ancient references, on the one hand, it is said that it comes from the basin of the Mediterranean, while others defend that it comes from the British Isles. It is probable that the cultivation began its development in the regions of the Middle East.

Regarding the taxonomy of the asparagus, there are several species of asparagus, among which are those that have an edible use and those that have a decorative use only. The species of asparagus cultivated today is a perennial plant, which belongs to the Liliaceae family and whose scientific name is *Asparagus officinalis* var. *altilis* L.

Image 4: White asparagus turions

Image 5: Asparagus plant leaves

With regard to the pests that affect the asparagus crop, there exists the following insects:

- Gray worm
- Spodoptera
- White worm
- Wire worm
- Heliotis
- Plusia
- Gardama
- Lepidoptera polyphagous

In addition, the sucking insects that affect the asparagus are thrips and aphids. Among the drilling insects that affect the cultivation of asparagus are the "Taladro del espárrago" and the "Asparagus fly".

Regarding the physicochemical aspects, the chemical composition of the asparagus is the following one:

- Energy (kcal): 18.0
- Protein (g): 2,7
- Carbohydrates (g): 1,1
- Fiber (g): 1,5
- Calcium (mg): 22,2
- Iron (mg): 1,1
- Magnesium (mg): 11,0
- Zinc (mg): 0,3
- Sodium (mg): 4,0
- Potassium (mg): 207,0
- Phosphorus (mg): 59,0
- Thiamine (mg): 0,12
- Riboflavin (mg): 0,13
- Niacin equivalents (mg): 1,4

The rest of the chemical composition corresponds to the water content of the product. In this case, around 94,7 g per 100 g of product.

The pH is between 4-6, for this reason, the heat treatment to be followed should be stronger than a pasteurization, so a sterilization will be necessary.

As for the production of ethylene, it is categorized as a non-climacteric vegetable since it is a very low production.

10.1.3. Water

Water is one of the main components of canned products, in this case of canned asparagus. The canned peppers that are going to be produced do not have government liquid with them.

The government liquid has the following functions:

- Improve the heat transmissions to the solid parts of the product.
- Remove the air trapped in the cans.
- Improve the flavor and the acceptability of the food product.
- It acts as a distribution medium for colorants and flavorings.

The water destined to food production in the food industry is ruled by Royal Decree 140/2003, of 7 February, which establishes sanitary criteria for the quality of water for human consumption, which exempts from this legislation that water supply in the food industry that ensures that its health does not affect the quality of the final product. As in this case, the sanitation and hygiene of the water that is going to be used in this food industry directly affects the microbial growth and the risks to which the products are exposed, that industry must comply with this decree.

10.1.4. Additives

First, the concept of additive is defined according to the Codex Alimentarius, in 1963, as follows:

"A food additive is any substance that is not normally consumed, even if it is of a nutritional nature and is not normally used as a characteristic ingredient of a food; whether or not it has nutritional value, it is intentionally added to a food with a technological or organoleptic purpose, at any stage of manufacture, processing, treatment, conditioning, packaging, transportation or storage of the said food and that may affect or directly (directly or indirectly) its incorporation or that of its derivatives in the food or may affect otherwise the characteristics of such food. The expression does not apply neither to contaminants nor to substances added to food in order to maintain or improve its nutritional properties "

In this case, an additive will be used for the production of canned peppers, both in Appellation of origin as in the production of piquillo variety peppers and in the production of canned asparagus. The additive is citric acid, which is used in the case of canned peppers to acidify them so that the heat treatment that must be applied is not a sterilization but a pasteurization at 100 °C. According to the International Numbering System for food additives, citric acid is numbered as E-330. Following this system, this additive has as technological functions:

- Color retention agent
- Antioxidant
- Acidity regulator

10.1.5. Salt

Salt is one of the main ingredients in canned vegetables it is added in the government liquid together with water and other additives. The functions of the steering fluid have already been explained above.

10.2. Auxiliary raw material

10.2.1. Packaging

Taking into account the Royal Decree 2420/1976, of June 2, which approves the technical-sanitary regulation for the preparation and sale of canned vegetables, the following general conditions apply to the materials involved in the packaging and production of any canned product.

Any material that has contact with food at any time of its preparation, processing, distribution and consumption, will maintain the proper conditions of conservation, hygiene and cleanliness and will meet the following conditions, in addition to those others that for each case are specified in the Spanish Food Code (SFC). These conditions are the following:

- Being manufactured with raw material approved by the SFC.
- Do not transmit toxic substances to the food product that can contaminate them.
- Control the authorized and not authorized substances in the food product composition
- Do not alter the characteristics of composition and organoleptic aspects of the food.

This industry will use as packaging material, glass and tin. The glass is going to be used in the canned products that will be covered by the Appellation of Origin and the Specific Appellation. So, the canned products "Pimiento del Piquillo de Lodosa" and "Espárrago de Navarra" will be packaged in glass packages. The capacity of the pepper bottles will be 314 ml and the capacity for the asparagus glass bottles will be 580 ml. The characteristics of the packages are the following ones:

Table 3: Characteristics glass packages

Format (ml)	top diameter of the bottle (mm)	Bottle Diameter (mm)	Height (mm)
314	63	68	131
580	63	77	172

Regarding the rest of the products, they will be packaged in metal cans, the asparagus cans will have a capacity of 720 ml and the pepper cans will have a capacity of 425 ml. The following table shows the dimensions of the tin cans.

Table 4: Characteristics metal cans

Formato (ml)	Diameter (mm)	Height (mm)	Large (mm)	width (mm)
425	83	85		
720		58	155	80

Regarding the closure systems of the cans, the Spanish Food Code conditions the materials of its manufacture in the following way:

- Metal caps coated or not with tin, varnish or enamel; of ceramic materials, porcelain, glass, waterproof cardboard or plastic materials, which ensure a perfect fit, with or without rings of cork, rubber, conglomerates and plastic materials or by welding.
- Crown-type caps coated with plastic film, aluminum, tin or with a cork disc on their contact surface with food and according to the requirements of preservation of the contents of the container.
- Metal capsules for bottles, as long as they are isolated by a sheet of tin paper one tenth of a millimeter thick or an aluminum foil or other impermeable material and unassatable in cold by 6% acetic acid.
- Cork caps, wood, rubber or plastic materials.

The selected covers for the glass cans will be of metal type covered with plastic materials in order to ensure a perfect closure. They will be caps that allow to be sterilized and pasteurized, so they will be able to hold temperatures of more than 120 °C. The characteristics of these closing systems are the following:

Table 5: Diameter of the closure system for the glass bottles

Format (ml)	top diameter of the bottle (mm)	Bottle Diameter (mm)	Height (mm)
314	63	68	131
580	63	77	172

10.2.2. Labelling

The information that must appear compulsory in food labeling is reflected in the "General norm of labeling, presentation and advertising of food products", approved by Royal Decree 1334/1999 of July 31. In addition, taking into account that canned products covered by an Appellation of Origin and other products covered by a the Specific Appellation are going to be produced, there are more restrictions that provide the specifications of each one of them. These requirements are described in *Document 4. Specification sheet.*

There is also a specific regulation for the labelling of asparagus that must be complied with which is Royal Decree 946/2003, of July 18.

As previously mentioned, one part of the peppers production will be produced under the Appellation of Origin Piquillo de Lodosa and one part of the asparagus production under the Specific Appellation Asparagus of Navarra, so that in its corresponding labelling should appear the following images.

Image 6: Specific appellation and appellation of origin labels

10.2.3. Pallets and carboard

Finally, they will be used in the industry pallets with the following measures: 1200 x 800 x 145 mm or 1200 x 1000 mm, two different types of pallets have been chosen to better adapt to the boxes to be used. The cardboard boxes that will be required in the company have the following dimensions:

Table 7: Cardboard boxes for the glass containers

Bottles format (ml)	Large (mm)	Width (mm)	Height (mm)	bottles capacity(bottle numer)
314	427	285	150	24
580	300	240	175	12

Table 6: Cardboard boxes of metal cans

Can format (ml)	Large (mm)	width (mm)	Height (mm)	bottles capacity(núm latas)
425	350	350	90	16
720	470	470	120	18

In order to get more information related with the raw material, it is recommended to go to the *Annex 3. Raw material analysis.*

11. Final product study

In this point the final products are described and this information is explained in depth in the *Annex 4. Final product study.*

11.1. Canned pepper

The annual pepper production will be of 470 t, being 150 t of pepper Appellation of Origin "Pimiento del Piquillo de Lodosa" and 320 t of piquillo pepper. The Appellation of Origin peppers will be packed in glass jars while the piquillo peppers will be packed in metal cans. The ingredients in this case are the peppers and the corresponding additive for the acidification of canned products.

The canned peppers that will be packed in metal cans will have a capacity of 425 ml and the final product will have a net weight of 400 g and a drained weight of 340 g. It is required in the package to leave a 6% vacuum for the headspace. The format to be presented will be, Piquillo peppers extra category 425 ml

In the case of canned pepper that will be packaged in glass jars, they will have a capacity of 314 ml with a net weight of 290 g and a drained weight of 260 g. The format to be presented will be, Pimiento del Piquillo de Lodosa extra category 314 ml

11.2. Canned asparagus

300 tons of canned asparagus will be produced, of which 200 tons will be white asparagus from Navarra, and the rest, 100 tons will be white asparagus from Navarra covered by the Specific Appellation "Espárrago de Navarra".

Regarding the canned asparagus that are presented in metal cans, they will be available in 1 kg format and they will be packed in cans of 720 ml capacity. In these cans a 6% vacuum is also required in the head space. The final product will have a net weight of 680 g and a drained weight of 408 g. The format of the final product will be, White asparagus can 6/8, extra category 1 kg (680 g), very thick.

Regarding the production of canned asparagus, apart from packaging in metal cans, there will be used also glass bottles.

The chosen glass bottle is a pot of capacity 580 ml. As in the previous cases, it is necessary to leave a 6% head space so that the closure is adequate and no damage occurs due to pressures in the sterilization. In this case about 35 ml of free space will be left. A net product weight of 540 g, a drained weight of 325 g, is proposed. The final product format to be presented will be, "Espárrago de Navarra" bottle 6/8, extra category 1 kg (540 g), very thick.

12. Analysis of alternatives: Production Process technology

In this section, the flux diagrams of the process technology are described, in addition to the different alternatives that have been chosen.

12.1. Canned pepper

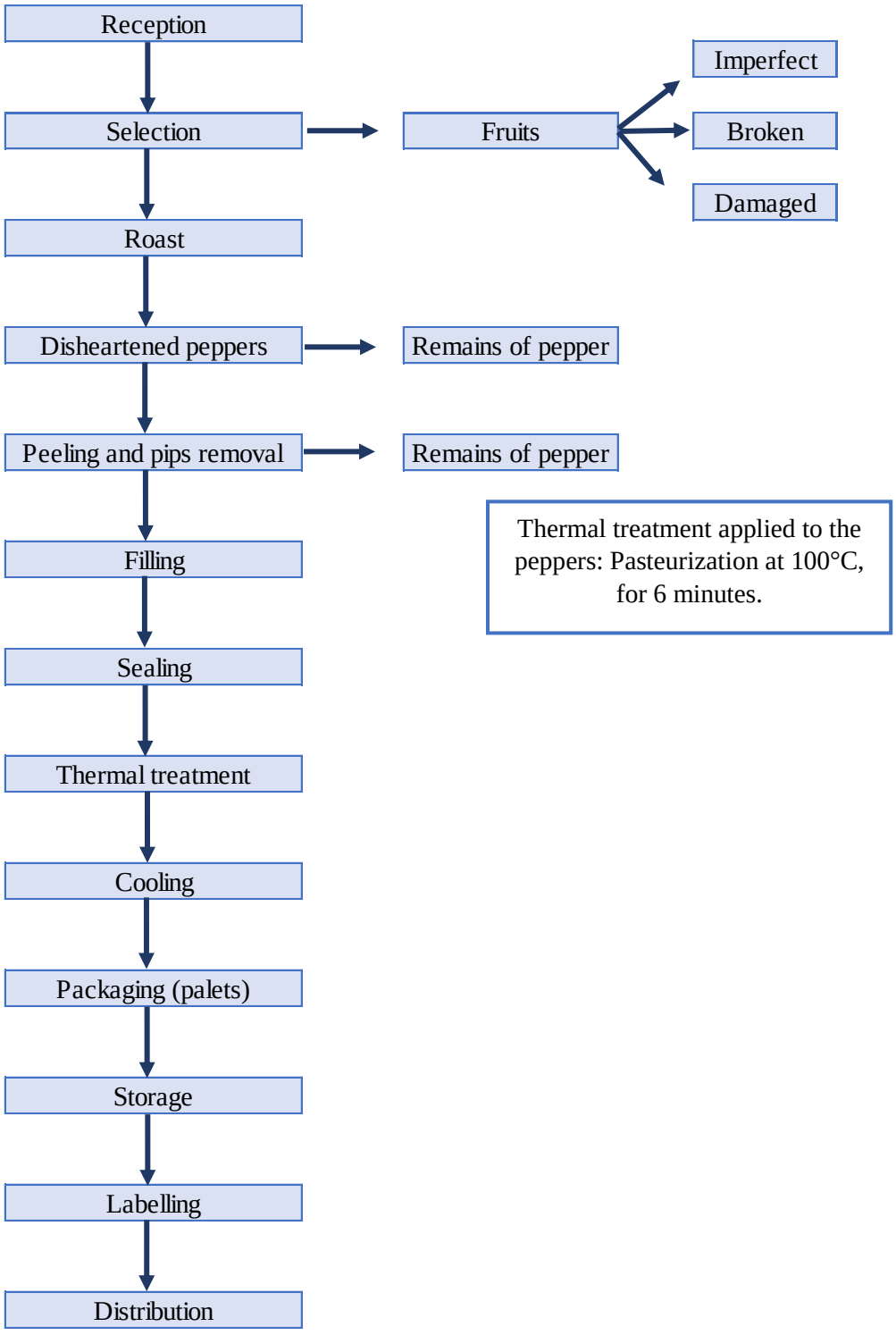


Figure 4: Process technology flux diagram, canned peppers

12.2. Canned asparagus

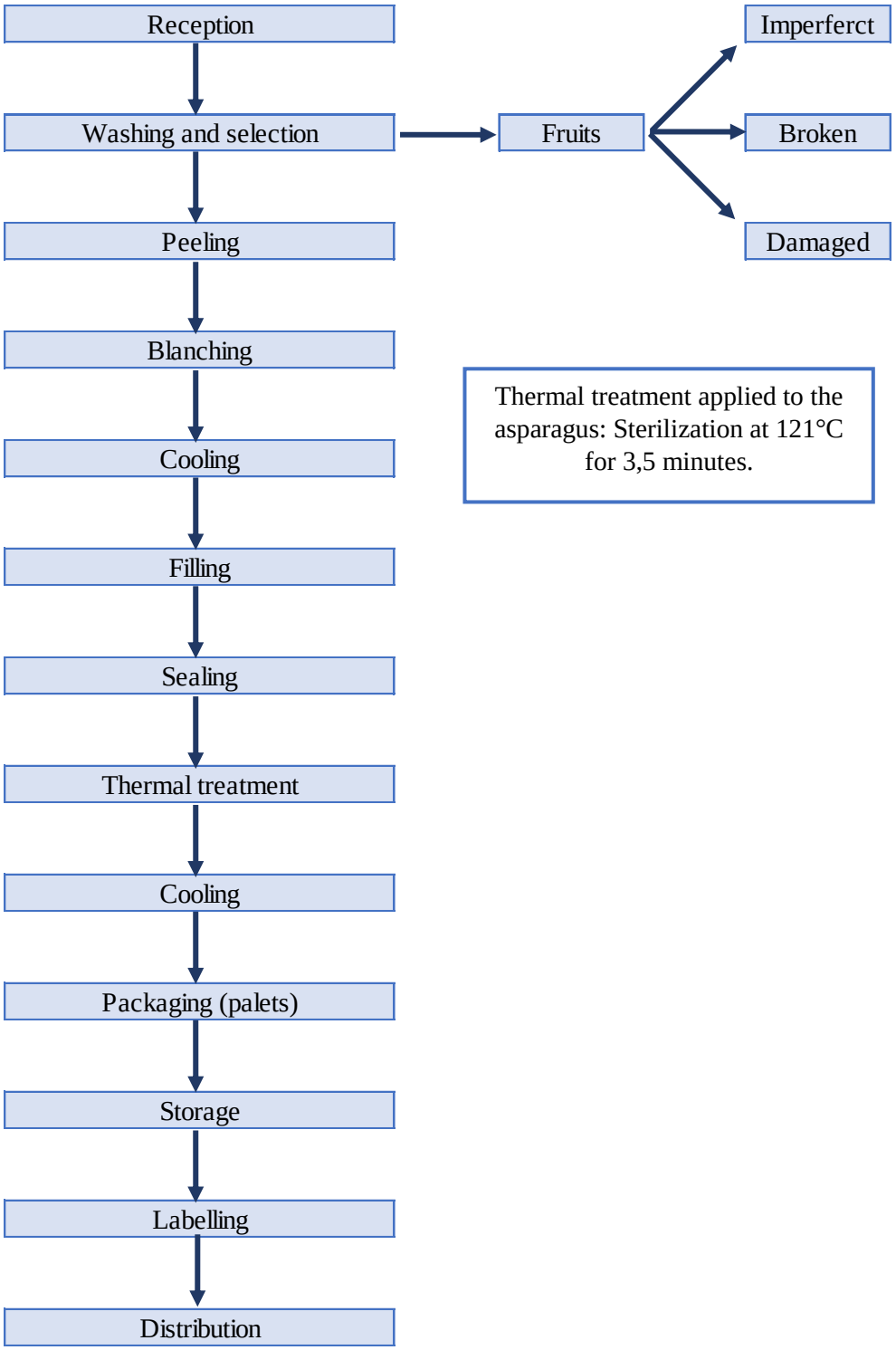


Figure 5: Process technology flux diagram, canned asparagus

12.3. Chosen alternatives

In almost all stages of the production processes of canned asparagus and peppers, problems have arisen to which there were certain alternatives that are described in depth in *Annex 6. Production process technology*. In addition, the stages of the production process together with the machinery and the necessary spaces can be found in *Drawing 5. Industry layout*, located in *Document 3. Drawings*. The chosen alternatives are summarized below.

12.3.1. Elaboration method

It is decided to follow the elaboration method guided by the appellation of origin for the peppers production and the Specific Appellation for the asparagus.

12.3.2. Selection

Regarding the selection of the product that enter the process cycle, an automatized method is chosen by using an optical selector of the material in both cases, peppers and asparagus.

12.3.3. Washing

The washing stage takes place in the canned asparagus process and it is chosen a humid method in order to obtain and efficient and not harmful method to the product.

12.3.4. Roast

The roast stage takes place in the canned pepper production and regarding the specification sheet of the appellation of origin it is necessary to use a direct flame roast.

12.3.5. Disheartened peeling and pips removal

Regarding the canned pepper case, this specific stage Will be carried out by the workforce that will be in the industry. While, in the case of canned asparagus, this specific stage will be carried out by and automatized method using a machine that simulates the knife peeling.

12.3.6. Blanching

This stage takes place in the canned asparagus production and the chosen alternative is a washing at 95°C for 3 minutes while the product is going through the blanching equipment by immersion. The method that will be used is specific for the asparagus as the product is moving across the machine with the buds not touching the water and getting heated by the water vapor.

12.3.7. Filling

In both productions, it is decided to use a manual filling method carried out by the personnel working.

12.3.8. Thermal treatment

The thermal treatment chosen in the canned pepper is a pasteurization at 100°C for 6 minutes as it is and acidified canned product. In the other case, as it is not an acidified product, it is necessary to apply and sterilization to the asparagus for 3,5 minutes at 121°C.

13. Analysis of alternatives: Process engineering

In this point, the chosen alternatives are mentioned regarding the process engineering, in order to get more information about the process engineering it is recommended to go to the *Annex 7. Production Process engineering.* The machinery that have been chosen with the necessary spaces for them are located in the *Drawing 5. Industry layout* that is in the *Document 3. Drawings.*

The next figures show the two flux diagrams regarding the process engineering.

13.1. Canned pepper

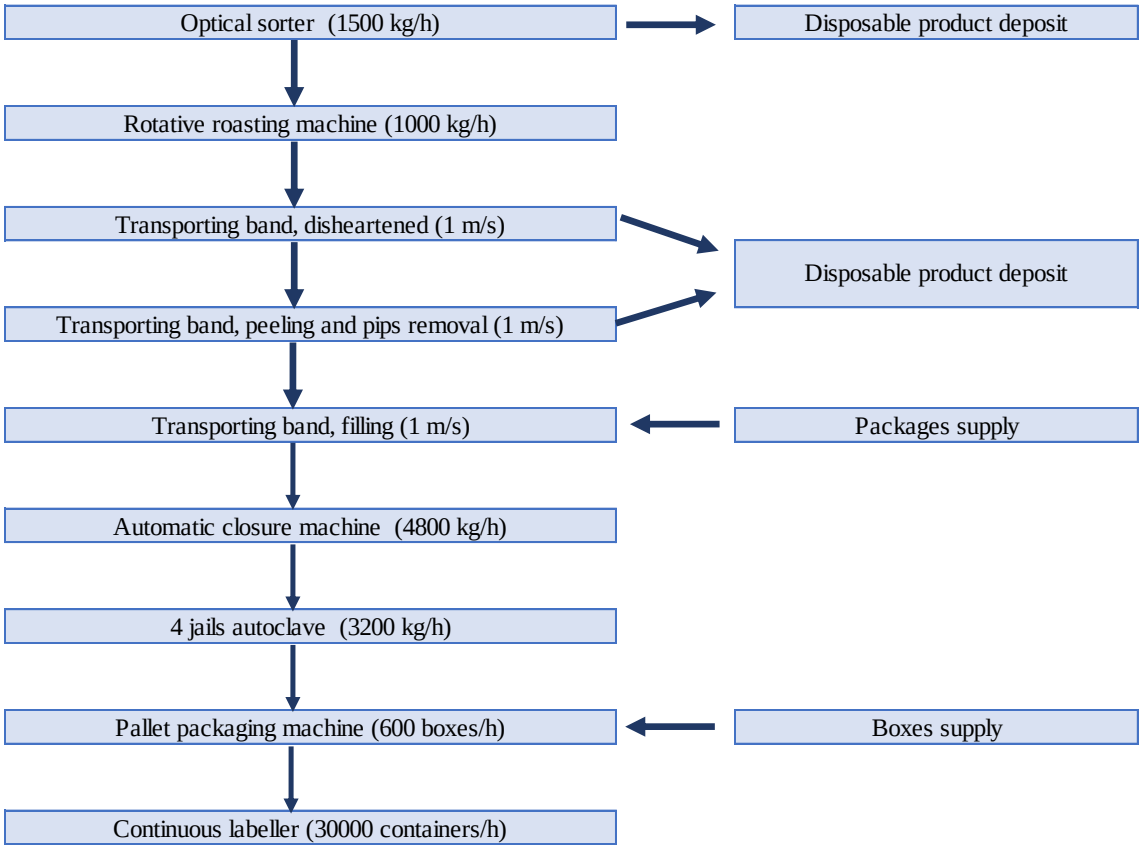


Figure 6: Process engineering flux diagram, canned pepper

13.2. Canned asparagus

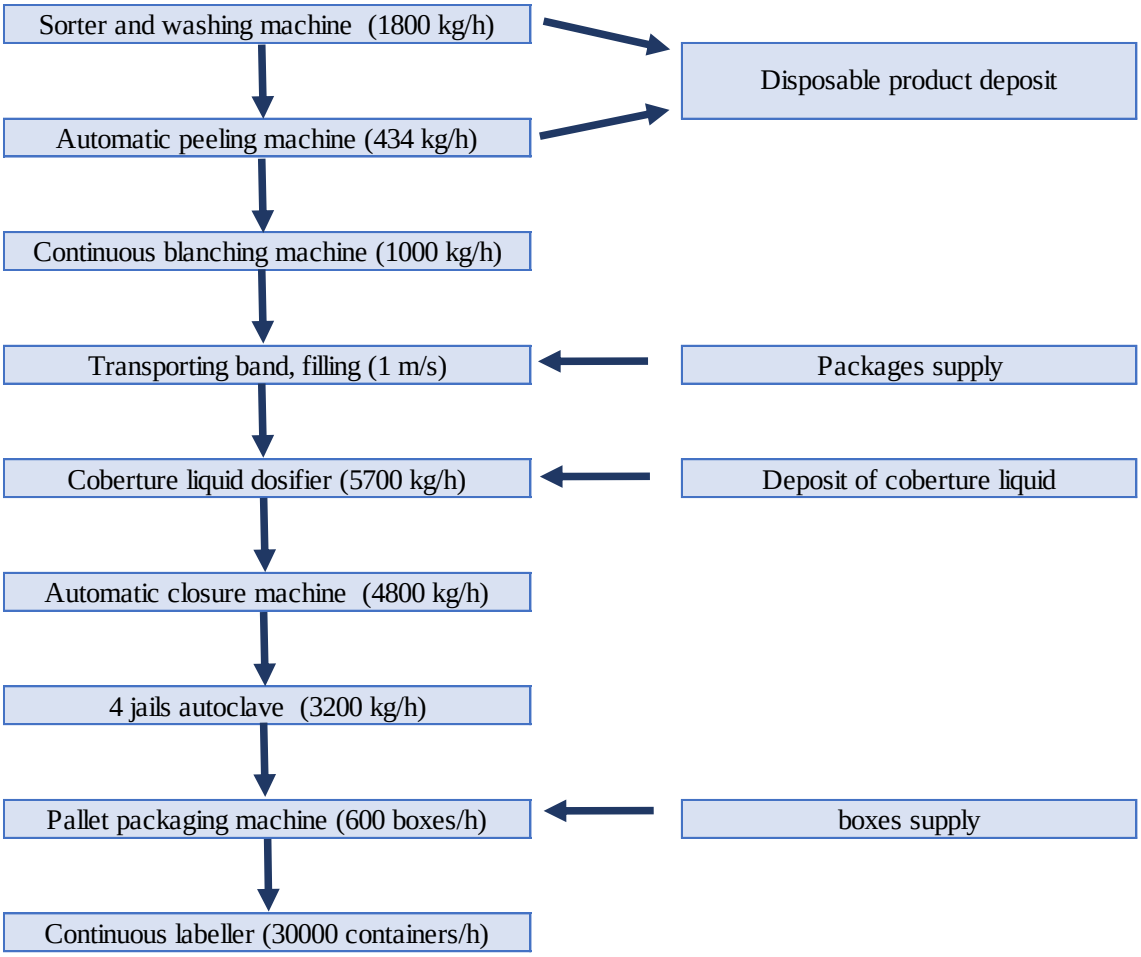


Figure 7: Process engineering flux diagram, asparagus preserves

13.3. Chosen alternatives

The next figures show the chosen alternatives regarding the process engineering.

13.3.1. Canned pepper

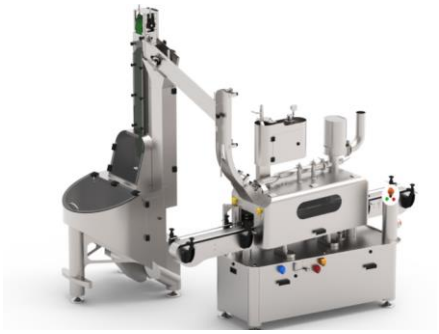
Description		
Sorter based on sensors and pulsed light LED managed from a simple user interface, capable of detecting foreign material, color defects, spots and flaws.		
Dimensions	Length (mm)	1000
	Width (mm)	2748
	Height (mm)	1332
Capacity (kg/h)		1500
		

Description		
Rotary roast machine of peppers by direct flame action with hopper of entrance and exit of product. Cylindrical structure and has a security system that detects foreign bodies.		
Dimensions	Length (mm)	5000
	Width (mm)	3000
	Height (mm)	3000
Capacity (kg/h)		1000
		

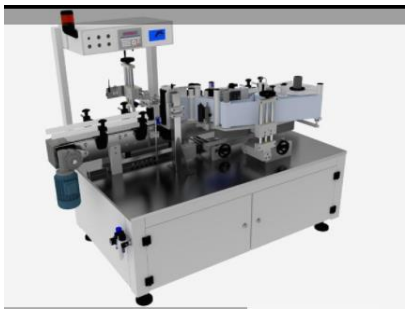
Description		
Transporting bands used in the desrorazonado, peeling and ginning of the pepper. Installed in a circular way so that it is an infinite circuit in each stage		
Velocity (m/s)		1
		

Description		
Closing machine of cylindrical metallic cans with 4 closing heads. Accepts cans with a diameter between 47 and 105 mm and heights from 25 to 120 mm. Finished in stainless steel.		
Dimensions	Largo (mm)	2000
	Ancho (mm)	1024
	Alto (mm)	1763
Capacity (kg/h)		4800
		

Figure 8: Chosen machinery for the pepper production line 1/2

Description		
Closer of cylindrical glass containers, with an ergonomic design that facilitates the cleaning of the equipment. Designed under the standards of food safety		
Dimensions	Length (mm)	2900
	Width (mm)	2300
	Height (mm)	2620
Capacity (kg/h)		4800
		

Description		
Discontinuous sterilization systems. They have 4 cages and the diameter of the equipment is 1520 mm. They are connected to an automatic circuit of movement of the cages.		
Dimensions	Length (mm)	4500
	width (mm)	2300
	Height (mm)	2620
Capacity (kg/autoclave)		3200
		

Description		
Automatic packaging labeling equipment. Designed for the labeling of containers of cylindrical character in the food industry		
Dimensions	Length (mm)	2500
	Width (mm)	1000
	Height (mm)	1800
Capacity (kg/h)		12000
		

Description		
Packaging in pallets system that is placed in the end of the production process before the labelling		
Dimensions	Length (mm)	5000
	Width (mm)	5000
	Height (mm)	2000
Capacity (Boxes/h)		600
		

Figure 9: Chosen machinery for pepper production line 2/2

13.3.2. Canned asparagus

Description		
System of washing and selection of asparagus, classifying those of interest for the industry. It consists of two equipment connected by a product conveyor belt. First the asparagus goes through the washing and then it is classified		
Dimensions	length (mm)	10000
	width (mm)	700
	Height (mm)	2000
Capacity (kg/h)		1800


Description		
Automatic asparagus peeling system, designed to simulate the manual peeling action of the product. Number of variable heads.		
Dimensions	Length (mm)	1650
	Width (mm)	1600
	Height (mm)	2000
Capacity (kg/h)		868

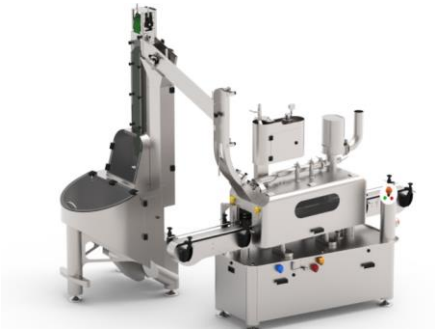
Description		
Blanching equipment by immersing the product in metal cans. It has a system to dump the boats getting the product to communicate with the next team.		
Dimensions	Length (mm)	7000
	Width (mm)	1200
	Height (mm)	1400
Capacity (kg/h)		1000

Description		
Closure equipment for non-circular cans. It has a closing carousel with 5 heads. It is a continuous system of closed containers.		
Dimensions	Length(mm)	4500
	Width (mm)	1925
	Height (mm)	1950
Capacity (kg/h)		6480

Figure 10: Chosen machinery for asparagus production line 1/2

Description		
Discontinuous sterilization systems. They have 4 cages and the diameter of the equipment is 1520 mm. They are connected to an automatic circuit of movement of the cages.		
Dimensions	Length (mm)	4500
	width (mm)	2300
	Height (mm)	2620
Capacity (kg/autoclave)		3200

Description		
Closer of cylindrical glass containers, with an ergonomic design that facilitates the cleaning of the equipment. Designed under the standards of food safety		
Dimensions	Length (mm)	2900
	Width (mm)	2300
	Height (mm)	2620
Capacity (kg/h)		4800



Description		
Packaging in pallets system that is placed in the end of the production process before the labelling		
Dimensions	Length (mm)	5000
	Width (mm)	5000
	Height (mm)	2000
Capacity (Boxes/h)		600

Description		
Automatic packaging labeling equipment. Designed for the labeling of containers of cylindrical character in the food industry		
Dimensions	Length (mm)	2500
	Width (mm)	1000
	Height (mm)	1800
Capacity (kg/h)		12000

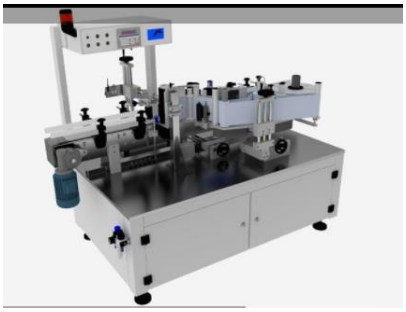


Figure 11: Chosen machinery for asparagus production line 2/2

14. Piping installation

In this point the piping installation of the industry is described in a resumed form, in order to see the complete calculus and design it is recommended to go to the *Annex 8. Piping installation.* The graphic information related to the piping installation is in the *Drawing 7. Piping installation* that is in the *Document 3. Drawings.*

The installation begins with the point of water supply for the industrial park 2 of Lodosa.

The water supplied has a pressure of 2 barg. From this point, the piping net for the cold water that will provide water needed to the machinery, the laboratory, personnel and office restrooms and the changing rooms is designed.

The designed pipes will be made of stainless steel approved by the ASME B31.1 standard and will have sections in which it will be buried, other sections that will be stuck to the wall at ground level and others that will have to be supported to a certain height to avoid doors.

The process to follow begins with the tool Piping and Instrumentation Diagram (P&ID), that consists in a graphic representation in a scheme way in which the pipes that will form each line with the data of pressure and diameters of each terminal point are shown. Assuming that, the terminal points are the machinery and everything that have water requirements, for instance the restrooms or the laboratory.

Following the graphic representation of the piping system, the hydraulics calculus that can be consulted in the *Annex 8. Piping installation* are done, getting by this way all the diameters, water flows and velocities, starting with a maximum velocity inside the pipe of 2 m/s.

There are two different zones in the industry, one area in which the machinery of the two production lines will be placed and other area in which the laboratory, the restrooms (personnel and office ones) and the changing rooms are placed. The piping system of cold water for these two different areas have been designed in addition to the hydraulic calculus of the piping system of warm water for the restrooms, changing rooms and vapor supply for the autoclaves.

14.1. Piping and Instrumentation Diagram (P&ID)

By the P&ID tool it is represented a scheme of the installation with all the water consumers. Then, it has been done an estimated outline of the pipes in the industry, by this way it has been possible to estimate the pipe meters requirement along with the elbows, and teas. With this information it is possible to calculate the head losses in any point of the installation. In this scheme, it is added the information about the dimensioning of the pipes that is presented in the hydraulics calculus.

The aim of using the P&ID is to make a pressure needs study in order to know the required pressure in each point, so that it is observed that the supply point of water provides water with 2 barg of pressure and the sterilization machinery need 3,92 barg. For this reason, is required a pressure group for the cold water system. The barg is a pressure unit used in this installation and it indicates the relative pressure that a manometer would mark.

In order to be able to calculate the pressure group that is required, the head losses from the pressure group to the autoclaves must be calculated, as the required pressure in the autoclaves is the most restrictive one. The head losses generated by the pipe from the autoclave to the pressure group must be added to the restrictive pressure. Thus, it is calculated the Pout of the required bomb. In order to calculate the Pin it is necessary to know the head losses that generates the pipe from the water supply point to the pressure group. (Pin is the pressure at the entrance of the bomb and the Pout is the pressure at the exit of the bomb).

Once the pressure group is calculated, the pressures with which the water will arrive to the restrooms, laboratory and changing rooms are calculated also. The collector of the restrooms and changing rooms is connected to the pressure group.

Despite the fact that with the pressure that the water has from the supply point would have been enough to provide the restrooms and changing rooms, it is included an emergency shower in the laboratory that requires a pressure between 2-8 barg by the Regulation EN15154-1-2 (European regulation for emergency showers). By this way, it is ensured the required pressure greater than 2 barg in the emergency shower.

In the scheme, the restrooms near the changing rooms are the Restroom 1 and Restroom 2 and the restrooms that are placed close to the offices and the laboratory are Restroom 3 and Restroom 4. In the equipment that require a lower pressure than the one that the pressure group is giving to them will be necessary to apply pressure reducer devices in order not to cause damage to the machinery.

The graphic representation of the P&ID can be found in the *Annex 8. Piping installation* in which the pressure data is calculated along with the complete hydraulics calculus of the pipes.

14.2. Hydraulics calculus

Firstly, the consumers must be localized in the installation, then the water flow and the required pressure in each terminal point have been taken into account. Regarding the water flow and the initial velocity of 2 m/s the internal, external and nominal diameter are calculated. Once, the diameters are selected the velocity is recalculated in order to check that is truly between 0-2 m/s. The terminal points will be in one line or general collector, thus, there will be one single collector for the machinery area and another one for the restrooms, changing rooms and laboratory. The nominal diameters of the pipes are provided by the supplier Aceros y Suministros S.A. that are shown in the next table.

Table 8: Pipes diameters

DN [mm]	DN [in]	D int [mm]	D ext [mm]	Espesor [mm]
15	1/2"	15,76	21,3	2,77
20	3/4"	21,16	26,9	2,87
25	1"	26,94	33,7	3,38
40	1-1/2"	40,94	48,3	3,68
50	2"	52,48	60,3	3,91
65	2-1/2"	65,68	76	5,16
80	3"	77,92	88,9	5,49
100	4"	102,26	114,3	6,02
150	6"	154,08	168,3	7,11

In order to get more information about the pipes calculation it is recommended to go to the *Annex 8. Piping installation.*

14.3. Chosen pressure group

Finally, regarding the installation needs and the required pressure for the bomb the following group of pressure is selected.

Table 9: Chosen pressure group

TIPO BOMBA	POTENCIA NOMINAL	Q = CAUDAL												
		l/min 0	167	267	340	367	467	540	660	700	800	860	920	967
		m3/h 0	10	16	20,4	22	28	32	39,6	42	48	52	55	58
	kW	H = ALTURA TOTAL METROS COLUMNA DE AGUA												
15SV01F011T	2 x 1,1	14		12,9	12,4	12,2	11,3	10,4	8,4	7,6	5,1			
15SV02F022T	2 x 2,2	29		26,7	25,9	25,5	23,9	22,4	18,9	17,4	13,1			
15SV03F030T	2 x 3	43		40,4	39,1	38,6	36,2	33,8	28,7	26,5	20,1			
15SV04F040T	2 x 4	58		54,7	53,1	52,5	49,4	46,3	39,7	36,9	28,7			
15SV05F040T	2 x 4	73		67,8	65,8	65,0	61,0	57,1	48,7	45,2	34,9			
15SV06F055T	2 x 5,5	88		81,5	79,4	78,4	74,1	69,9	60,3	56,3	44,2			
15SV07F055T	2 x 5,5	102		94,5	91,9	90,8	85,7	80,6	69,4	64,7	50,5			
15SV08F075T	2 x 7,5	117		110,9	108,0	106,8	100,8	94,9	82,0	76,7	60,6			
15SV09F075T	2 x 7,5	132		124,4	121,0	119,6	112,8	106,1	91,5	85,5	67,4			
15SV10F110T	2 x 11	148		138,8	135,3	133,8	126,7	119,6	103,9	97,4	77,5			

15. Refrigeration installation

In this point, the calculus and design of the refrigeration chamber is described in a resumed way, in order to get more information about the refrigeration installation it is recommended to go to the *Annex 9. Refrigeration installation.* The graphic information about this specific installation can be found in the *Drawing 6. Refrigeration installation* that is in the *Document 3. Drawings.*

In this industry, canned pepper and asparagus are going to be produced. The one that is selected as a reference in order to calculate the refrigeration chamber is the asparagus because of the following reasons.

The pepper is a summer cultivation and temperatures below 7°C are not beneficial for it. The temperature conditions of storage are between 8-10°C, Nevertheless, the asparagus cultivation requires lower temperatures for an optimum storage. The temperature conditions that are beneficial for the asparagus are between 0-2°C and with a relative humidity close to a 100%. For this reason, the asparagus is chosen as product reference for the refrigeration chamber.

15.1. Chamber design

In order to make a correct design it is necessary to know the characteristics of the raw material that is going to be stored.

Table 10: Characteristics of raw material

Denomination	Asparagus
Storage density (kg/m3)	140
Freezing temperature (°C)	-1,5
Cp before freezing (kJ/kg°C)	3,94
Latent heat of freezing (kJ/kg°C)	250
Cp after freezing (kJ/kg°C)	2,09
Respiration heat at 25°C (kJ/kgdía)	13,82
Respiration heat at 0°C (kJ/kgdía)	0,84

It is estimated a capacity of the chamber of tons, that covers the production capacity of 3 days. It is considered a product entrance of 33,3% at a temperature of 30°C and a 5% of the pallets weight, regarding this information it is obtained a chamber with the following dimensions: 6,4 x 4,4 m. The following table shows the walls, floor and ceiling materials.

Table 11: Walls, floor and ceiling materials

Chamber side	Material	Thickness (cm)	Conductivity (W/m ^{2} °C)	Heat losses (W/m ^{2})
Walls and ceiling	Expanded polyurethane *	10	0,2222	7
Floor + insulating	Concrete + expanded polyurethane in plates	12 + 5,5	0,4464	7,1

*
Sandwich panel with insulating of polyurethane, the metal part can be made of steel or aluminum and it is not taken into account or the heat conduction calculus.

15.2. Calculus

In order to make the calculations it has been taken into account the loads that the chamber will have, apart from the ones related to the product cooling. The following tables show the loads and final results about the refrigeration power of the chamber.

Table 12: Refrigeration chamber loads

	Loads	Thermal power	
Installation	Air renovation	0,64	kW
	Personnel	0,54	kW
	Illumination	0,23	kW
	Ventilators	0,68	kW
	Walls and ceiling	1	kW
	Machines and engines	0,75	kW
	Total	3,84	kW
Product	Product cooling	6,84	kW
	Product respiration	1,02	kW
	Pallets cooling	0,236	kW
	Total	8,126	kW

Table 13: Chamber final results

Final results	Thermal power	
Total load of the chamber	12	kW
Total load of the chamber majored	13,2	kW
Rerigeration power of the chamber, working 18 h	17,5	kW
Installed power per m^3	156	W/m^3

As it can be seen observed in the table 13 of results, it has been applied a mayoration coefficient and the final refrigeration power of the chamber must be 17,6 kW. Once the calculus is done, the appropriate machinery must be chosen. The equipment that has been chosen are the following ones:

- Evaporator: MKH-NY-1245, with a refrigeration power of 17,7 kW
- Compressor: 10GR50.3X R-134, with 8 kW of power
- Condenser: CBN 29, with 28,5 kW of power

15.3. Pipes calculation

Finally, it is presented the results table about the aspiration, discharge and liquid pipe for the refrigeration installation.

Table 14: Final results of the refrigeration pipes

Denomination	Maerial	Fluid v (m/s)	Accessories head loss (Pas)	Friction factor
Refrigerant	DN (")	Head loss (°C)	Density (kg/m3)	
Pipe type	Real Length (m)	Head loss (kg/cm2)	Absolut rugosity	Recommended
XV	Internal D (mm)	Head loss by height	Reynolds number	
Aspiration of raw material chamber	Copper (standard bars)	3,472	0,001902	0,01517
R-134a	1,65"	0,04616	0,002426	
Aspiration	13,65	0,004328	400	Recommended
1	63,38	0	24,35	
Aspiration of raw material chamber	Copper (standard bars)	10,46	0,05929	0,01364
R-134a	0,8"	0,5603	0,1107	
Discharge	4,8	0,17	400	Recommended
1	17,45	0	7,371	
Aspiration of raw material chamber	Copper (standard rolls)	0,3656	0,006109	0,02076
R-134a	1"	1,569	0,01334	
Liquid	16,95	0,4704	400	Recommended
1	20,22	0,451	24,71	

16. Industrial activity planning

In this point, the industrial activity planning is described in a resumed way and in order to get more information it is recommended to go to the *Annex 5. Industrial activity planning.*

In this industry, the industrial activity will consist in the elaboration of two different canned vegetables. The products will be, canned piquillo pepper and asparagus. The annual production of the industry will be 770 tons. This production is divided in two final products by the following way:

- Production of canned piquillo pepper:
  - Appellation of Origin “Pimiento del Piquillo de Lodosa”, 150 t.
  - Canned piquillo pepper, 320 t.
- Production of canned asparagus:
  - Specific Appellation “Espárrago de Navarra”, 100 t.
  - Canned asparagus from Navarre, 200 t.

The calendar has been organized as follows, it has been taken into account only the business days of each month and each month has been divided in 3 squares, assuming each square as one week of work. The weeks correspond to 7 business days as the whole calculus is done based on these days and not-business days and weekends are not taken into account. During the two seasons of production, it is necessary to apply 2 working times per day, one during the morning ad will consist in 8 hours of work and the second one during the evening with 6 hours of work.

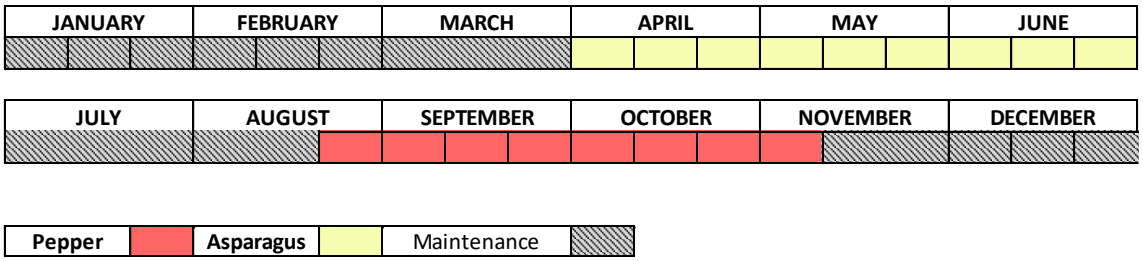


Figure 12: Industrial activity planning calendar

16.1. Canned pepper

The annual production of pepper in this industry will be 470 tons. This production is divided in two, as one part will be covered by the Appellation of Origin “Pimiento del Piquillo de Lodosa”, while the other part will be of piquillo pepper and will not be covered by the appellation of origin.

Due to the fact that the production is divide in two phases, it is categorized as sequential, being produced firstly the piquillo pepper phase and then the phase covered by the appellation of origin. In order to organize each phase, the productive process has focused in the intermediate stage that is the sterilization and is discontinuous. Thus, based on the production of each phase, one or two shifts in the autoclave will be required.

The timing of the three stages of the productive process has been calculated and it is summed up in the following figures.

Time (min)													
0	A		110	A		215	A	B	320		B	430		B
5	A		115	A		220	A	B	325		B	435		B
10	A		120	A		225	A	B	330		B	440		B
15	A		125	A		230	A	B	335		B	445		B
20	A		130	A		235	A	B	340		B	450		B
25	A		135	A		240	A	B	345		B	455		B
30	A		140	A		245	A	B	350		B	460		B
35	A		145	A		250	A	B	355		B	465		B
40	A		150	A		255	A	B	360		B	470		B
45	A		155	A		260	A	B	365		B	475		B
50	A		160	A		265	A	B	370		B	480		B
55	A		165	A		270	A	B	375		B	485		B
60	A		170	A		275	A	B	380		B	490		B
65	A		175	A		280	A	B	385		B	495		B
70	A		180	A		285	A	B	390		B	500		B
75	A		185	A		290	A	B	395		B	505		B
80	A		190	A		295	A	B	400		B	510		B
85	A		195	A		300	A	B	405		B	515		B
90	A		200	A	B	305	A	B	410		B	520		
95	A		205	A	B	310	A	B	415		B	525		
100	A		210	A	B	315	A	B	420		B	530		
105	A		215	A	B	320	A	B	425		B	535		

Stage 1		Stage 2		Stage 3	

Figure 13: Piquillo pepper production

The figure shows the piquillo pepper phase with the two shifts in the autoclave represented by the letters A and B. As it can be observed in the figure, at 7 hours and 45 minutes to start, it will be everything processed and it will be necessary the packaging in pallets of the second shift. One part of the personnel corresponding to the second working time of the day will supervise the last packaging in pallets of the first working time of the day. Then, it will be necessary to dedicated 30 minutes to clean the building.

Time (min)

0	C	110	C	220	C
5	C	115	C	225	C
10	C	120	C	230	C
15	C	125	C	235	C
20	C	130	C	240	C
25	C	135	C	245	C
30	C	140	C	250	C
35	C	145	C	255	C
40	C	150	C	260	C
45	C	155	C	265	C
50	C	160	C	270	C
55	C	165	C	275	C
60	C	170	C	280	C
65	C	175	C	285	C
70	C	180	C	290	C
75	C	185	C	295	C
80	C	190	C	300	C
85	C	195	C	305	
90	C	200	C	310	
95	C	205	C	315	
100	C	210	C	320	
105	C	215	C	325	

Stage 1		Stage 2		Stage 3	

Figure 14: Appellation of origin pepper production

This figure shows the Appellation of Origin pepper production and its only shift. As it can be observed in the figure, the shift consists in 5 hours of work, with time enough to clean the industry after the production.

16.2. Canned asparagus

The annual production of asparagus in this industry will be 300 tons. This production is divided in two due to the fact that one part of it will be covered by the Specific Appellation “Espárrago de Navarra”, while the rest of the production will be of white asparagus from Navarre and will not be covered by the quality brand.

As in the previous case, the production will be sequential because of the two different formats that are going to be produced. The productive process is focused in the sterilization stage and two phases have been organized. The following two figures sum up the production of asparagus.

Time (min)							
0	A	105	A	210	A	315	A
5	A	110	A	215	A	320	A
10	A	115	A	220	A	325	A
15	A	120	A	225	A	330	A
20	A	125	A	230	A	335	A
25	A	130	A	235	A	340	A
30	A	135	A	240	A	345	
35	A	140	A	245	A	350	
40	A	145	A	250	A	355	
45	A	150	A	255	A	360	
50	A	155	A	260	A	365	
55	A	160	A	265	A	370	
60	A	165	A	270	A	375	
65	A	170	A	275	A	380	
70	A	175	A	280	A	385	
75	A	180	A	285	A	390	
80	A	185	A	290	A	395	
85	A	190	A	295	A	400	
90	A	195	A	300	A	405	
95	A	200	A	305	A	410	
100	A	205	A	310	A	415	

Stage 1		Stage 2		Stage 3	

Figure 15: White asparagus production

In this figure it is represented with the letter A the only shift in the autoclave that is necessary for the production of 3125 kg, the white asparagus production. As it can be observed in the figure, the working time of the morning will be 5 hours and 40 minutes, having this way enough time to the cleaning.

Time (min)					
0	B	105	B	210	B
5	B	110	B	215	B
10	B	115	B	220	B
15	B	120	B	225	B
20	B	125	B	230	B
25	B	130	B	235	B
30	B	135	B	240	
35	B	140	B	245	
40	B	145	B	250	
45	B	150	B	255	
50	B	155	B	260	
55	B	160	B	265	
60	B	165	B	270	
65	B	170	B	275	
70	B	175	B	280	
75	B	180	B	285	
80	B	185	B	290	
85	B	190	B	295	
90	B	195	B	300	
95	B	200	B	305	
100	B	205	B	310	

Stage 1		Stage 2		Stage 3	

Figure 16: Specific appellation Espárrago de Navarra production

In this figure can be observed with the letter B the only shift corresponding to the production of the phase Specific Appellation “Espárrago de Navarra”. The working time will consist in 3 hours and 56 minutes. Thus, it is obtained the required annual production and enough time to do the cleaning of the industry.

16.3. Workforce

For the industry in general, there is a manager, four laboratory technicians, two sales people, one employee responsible for the reception, three administrative assistants, one production manager and ten workers responsible for maintenance. These positions are fixed as to the number of them, however, the personnel in plant varies depending on the season that is. The graphic information about the necessary personnel and the machines in which they will work is found in *Drawing 5. Industry layout*, located in *Document 3. Drawings.*

16.3.1. Pepper season

In order to comply with the annual amount of pepper of 470 t, 20 people will be needed to work in the disheartened, another 20 in the peeling and pips removal and 20 in the filling of the product.

Therefore, taking into account the stages of the process that will be carried out manually, in the case of canned pepper, 60 workers will be required for the personnel in plant.

16.3.2. Asparagus season

In the case of the canned asparagus, the stage of the process that will be carried out manually is the filling that consists in to transporting bands with 8 persons per band, so 16 workers will be required.

Nevertheless, in previous stages that will be carried out by specific machinery is also needed to have people there.

- Washing and sorting: 7 people
- Automatized peeling: 2 people
- Blanching: 4 people
- Sealing: 1 person

Therefore, in order to obtain the annual production of asparagus of 300 tons, it is necessary 30 workers in plant.

17. Planning and control of the project execution

17.1. Activities and Gantt Diagram

One of the most important points of a project is the planning of its execution. To carry out an adequate control, the tool of the Gantt Diagram is used, in this case, is applied through the Microsoft Project 2010 computer program. To use this tool, it is necessary to indicate which activities make up this project and allocate an estimated time to each one of them. In addition, this tool allows to link or not an activity with another so that you can specify which activities can be carried out simultaneously. To see the full description of the planning and control of the execution of the project, go to *Annex 10. Planning and control of the project execution.*

The previous activities that have been considered before starting the indsutrial production are:

- Acondicionamiento de la planta (Building conditioning)
- Instalación de fontanería (Piping installation)
- Instalación frigorífica (Refrigeration installation)
- Instalación de las líneas de producción (Installation o the production lines)
- Puesta a punto de la maquinaria (Set-up for the machinery)

It has been estimated a specific time for each one and the Gantt Diagram is resuming all of them.

Id	Nombre de tarea	Duración	Comienzo	Fin
1	Acondicionamiento de la planta	1 sem	lun 14/01/19	vie 18/01/19
2	Instalación fontanería	2 sem.	lun 21/01/19	vie 01/02/19
3	Instalación frigorífica	2 sem.	lun 04/02/19	vie 15/02/19
4	Instalación líneas de producción	3 sem.	lun 18/02/19	vie 08/03/19
5	Puesta a punto de la maquinaria	1 sem	lun 11/03/19	vie 15/03/19

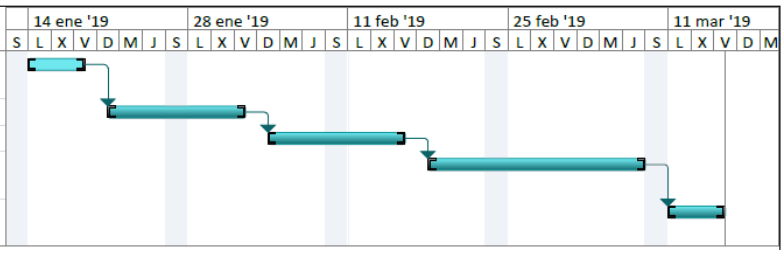


Figure 17: Gantt Diagram

17.2. Justification of spaces

The total surface of the selected plot is 5565 m^2 and in order to carry out a proper industry distribution layout, the surface and the urbanization have been take into account as in the south-east façade it is another neighboring plot that inhibit the access to the industry.

Furthermore, the need required for the production area, the raw material chamber, the elaborated product warehouse, the changing rooms and the restrooms have been taken into account. In this point, there is described the justification in a resumed way and in order to get more information it is recommended to go to the *Annex 10. Planning and control of the project execution.*

Table 15: Space needs in the production area

		Length (mm)	Width (mm)	Surface (m^2)
PEPPER	**Sorter machine**	5750	2250	12,94
	Roasting machine	6000	2050	12,30
	Transporting band	4000	2050	8,20
	Disheartened	8000	3500	28,00
	peeling and pips removal	8000	3500	28,00
	Filling	7000	7000	49,00
	Sealing	7000	6000	42,00
		TOTAL		180,44
		TOTAL (majored)		225,55
ASPARAGUS	**Washing and sorting**	6000	500	3,00
	Transporting bands and peeling	7000	7700	53,90
	Blanching	12600	3600	45,36
	Filling	6700	7200	48,24
	Coberture liquid	2620	800	2,10
	Sealing	4200	5200	21,84
		TOTAL		174,44
		TOTAL (majored)		218,05

Table 16: Space need or the automatized autoclave circuit

	Length (mm)	Width (mm)	Surface (m^2)
Automatized autoclave circuit	18500	17250	319,13
		majored	398,91

The raw material refrigeration chamber design is described in the *Annex 9. Refrigeration installation*, and the needs of surface of it is 28,16 m^2.

Assuming the elaborated product warehouse consists in two rows separated one from the other 3 m to leave enough space for the personnel to walk among them and each row with two pallets together, thus it has been estimated a surface need of 34,9 m of length and 11,1 m of width. By this way, the warehouse will have the enough surface of storing half of the pepper production that has been taken as a reference as it is greater than the asparagus one.

Lastly, taking into account Royal Decree 486/1997, of 14 April, which establishes minimum safety and health provisions in workplaces, 3 showers and 3 washbasins are estimated for the changing rooms and 3 toilets with 3 washbasins for the bathrooms. Therefore, the space needs for the service area and changing rooms, with a corridor that separates the gentlemen area from the women area, is 182,36 m^2.

The machinery and boiler rooms have direct access to the outside. The raw material refrigeration chamber has been arranged as close as possible to the machinery room.

The elaborated product warehouse has been arranged in such a way that there are direct connections with the production room and with the product expedition area. It has also been estimated a space for the reception of raw materials, packaging and additives, which connects with the raw material refrigeration chamber, with the production line and with the packaging and additives warehouse.

Finally, a space has been established for the reception of personnel and customers, from which the offices and laboratory or the production line can be accessed. The bathroom and changing area is located away from the production area. To check the graphic information about the justification of spaces, go to *Drawing 5. Industry distribution layout* located *in Document 3. Drawings.*

18. Economic study

In this section of the project, the economic-financial evaluation will be carried out and its objective is to quantify the cost of the project monetarily and analyze whether it is economically viable or not.

To carry it out, the payment of the investment, the cash flow, the time horizon will be studied and the indices of economic profitability, the Net Present Value (NPV), the Internal Rate of Return (IRR) and the recovery period will be used. of the investment, to check whether the project is viable or not.

Regarding the time horizon, taking into account the nature of the project in question and the budget for its execution amounting to 1601581,01 €, a useful life of 20 years is proposed.

18.1. Incomes

Table 17: Ordinary incomes

Product		Units/year	€/Unit	Annual incomes
Pepper	A.O.	520000	3	1560000
	Piquillo	800000	4	3200000
Asparagus	S.A.	186240	6,5	1210560
	White	294400	3,25	956800
			total (€)	6927360
			total (€) 60%	4156416

It is estimated that, being products with a very long useful life, at the beginning of the industrial activity it starts selling a 60%, in addition it has been applied a coefficient of reduction since business experience is needed to sell all the production. This sales data is estimated to normalize over the years so that revenues increase.

Regarding the extraordinary income, the sale of machinery at the end of its useful life is taken into account. A useful life of the machinery of 10 years is estimated, so there will be two extraordinary income. A value of 8% of the initial investment is taken as value for the machinery sold.

Therefore, in year 10, the extraordinary income will represent 140,472.32 €. In the year 20, the extraordinary income from the sale of used machinery, it is estimated a value 10% higher than the previous one due to the increase in the price of the machinery, that is, of 154519,552 €.

18.2. Expenses

Firstly, the cost of paying the investment. In order to acquire this investment a bank loan is solicitated for the quantity of 1601581,01 €, (for checking this quantity, go to the *Document 5. Measurements and budget*), with an interest of 10% and 15 years for paying it.

Table 18: Financial payment of the bank loan

Years	live capital (€)	Share (€)	interest (€)	Payment (€)
0	1601581,01			
1	1601581,01	0,00	160158,10	160158,10
2	1601581,01	0,00	160158,10	160158,10
3	1601581,01	0,00	160158,10	160158,10
4	1468115,92	133465,08	160158,10	293623,18
5	1334650,84	133465,08	146811,59	280276,68
6	1201185,75	133465,08	133465,08	266930,17
7	1067720,67	133465,08	120118,58	253583,66
8	934255,59	133465,08	106772,07	240237,15
9	800790,50	133465,08	93425,56	226890,64
10	667325,42	133465,08	80079,05	213544,13
11	533860,34	133465,08	66732,54	200197,63
12	400395,25	133465,08	53386,03	186851,12
13	266930,17	133465,08	40039,53	173504,61
14	133465,08	133465,08	26693,02	160158,10
15	0,00	133465,08	13346,51	146811,59

Secondly, the raw material expenses and the workforce salaries are presented.

Table 19: Raw material expenses

Raw material	Price/kg (€)	Annual kg	Total price (€)
Pepper	0,4	470000	188000
Asparagus	3	300000	900000
		total (€)	1088000

Table 20: Auxiliary material expenses

	Auxiliary material	Price/Unit (€)	Anual units	Total price (€)
Cardboard boxes dimensions (mm)	427 x 285 x 150	0,6	21700	13020
	300 x 240 x 175	0,6	17160	10296
	350 x 350 x90	0,6	55000	33000
	470 x 470 x 120	0,6	20240	12144
Glass bottles (ml)	314	0,25	650000	162500
	580	0,34	232800	79152
Metal cans (ml)	720	0,25	353280	88320
	425	0,15	1000000	150000
			Total (€)	548432

Table 21: Salary expenses

Personnel	Number/post	Monthly salary/person	Monthly salary expense (€)	Annual salary expense (€)
Manager	1	4000	4000	48000
Laboratory technicians	4	2000	8000	96000
Commercial	2	2200	4400	52800
Administration	3	1500	4500	54000
Production manager	1	2500	2500	30000
Maintenance	10	1900	19000	228000
Workers	30	1200	36000	108000
	60	1200	72000	180000
Reception	1	1300	1300	15600
			Total (€)	812400

Regarding the incomes and the expenses, the following cash flows are obtained (complete information about the incomes and the expenses in the *Annex 11. Economic study*)

Table 22: Cash flows

Years	Ordinary incomes (€)	Extraordinary incomes (€)	Ordinary expenses (€)	Extraordinary expenses (€)	Investment payment (€)	Cash flows (€)
0					1601581,01	-1601581,006
1	3117312		2448832	639175,0983	153069,98	-123765,08
2	3117312		2448832	639175,0983	153069,98	-123765,08
3	3117312		2448832	639175,0983	153069,98	-123765,08
4	3117312		2448832	639175,0983	280628,30	-251323,40
5	4156416		2448832	639175,0983	267872,47	800536,43
6	4156416		2448832	639175,0983	255116,64	813292,27
7	4156416		2448832	639175,0983	242360,80	826048,10
8	4156416		2448832	639175,0983	229604,97	838803,93
9	5195520		2448832	639175,0983	216849,14	1890663,76
10	5195520	140472,32	2448832	1854345,531	204093,31	828721,48
11	5195520		2448832	639175,0983	191337,48	1916175,43
12	5195520		2448832	639175,0983	178581,64	1928931,26
13	5888256		2448832	639175,0983	165825,81	2634423,09
14	5888256		2448832	639175,0983	153069,98	2647178,92
15	5888256		2448832	639175,0983	140314,15	2659934,75
16	5888256		2448832	639175,0983		2800248,90
17	6927360		2448832	639175,0983		3839352,90
18	6927360		2448832	639175,0983		3839352,90
19	6927360		2448832	639175,0983		3839352,90
20	6927360	154519,552	2448832	629175,0983		4003872,45

Finally, the profitability indexes that have been calculated previously are presented:

- NPV: 6.797.552,10 €.
- IRR: 26%
- Payback period: 7 years

19. General summary of budget

Table 23: General summary of budget

Summary (€)		
Production lines	Pepper	85052,70
	Asparagus	1019647,69
Installations	Refrigeration	10727,48
	Piping	28558,56
Budget (€)		1143986,43
I.V.A. (€)		240237,15
General expenses (€)		148718,24
Benefits (€)		68639,19
Project execution budget (€)		1601581,01

Thus, the Project execution budget amounts to ONE MILLION SIX HUNDRED ONE THOUSAND FIVE HUNDRED EIGHTY AND ONE EUROS, WITH ONE CENT.

Date: March 2018

Town: Lodosa

Sgd: Jose Javier Nuñez Iñarra

Student: Agri-food & Rural Environment Engineering

PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

Public University of Navarre

SCHOOL OF AGRICULTURAL ENGINEERING

Agri-food & Rural Environment Engineering

DOCUMENT 2. ANNEXES

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

March 2018

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PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

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ANNEX 1. LOCATION AND SITING

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

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1. Location and siting

1.1. Project location

The present project is located in the Autonomous Community of Navarra, in the town of Lodosa. The industrial park where the project is located is number 2, the chosen plot is number 270, located in sub-area 1, on “El Ramal” street at the corner with “Calderín” street. The surface of the plot is 5565 m^2.

Lodosa is a town located in the Autonomous Community of Navarra, located in the territory of Estella. It limits to the north with the town of Sesma, to the east with Cárcar, to the south with Padrejón (La Rioja) and Ausejo (La Rioja), and to the west with Sesma and Alcanadre (La Rioja). Lodosa is located 75 kilometers southeast of Pamplona, the capital of the community. Lodosa has an area of 45 km^2 and a population of 4738 inhabitants according to the 2016 census. (Town hall of Lodosa, 2018)

This location is chosen to carry out the project since one of the productions that are going to be elaborated is the canned piquillo pepper covered by the Appellation of Origin "Pimiento del Piquillo de Lodosa" that as its own name indicates is native of the town of Lodosa. This appellation is an extra quality brand to the product and in Navarre has a wide market with high sales figures every year. Lodosa is a village with an important economic activity related to agricultural production, its main crops are internationally known, among them are asparagus, tomato or piquillo peppers. This is due to the fact that its good infrastructure dedicated to these crops, in terms of rainfed and irrigated land and arable land. They have 892 hectares of irrigated land and 1954 hectares of dry land.

Lodosa has advantages in terms of communication with another of the important capitals of the autonomous community of Spain, with Zaragoza. From Lodosa, the AP-68 motorway is very accessible, along the NA-232 national road to reach the Aragonese capital. The capitals of the Basque Country, Bilbao, San Sebastián and Vitoria are also well connected with Lodosa.

As it has been mentioned above, Lodosa is a town of high level of agricultural activity, for this reason, it gathers the necessary resources to supply the industry with the raw materials and other elements that intervene in the productive cycle needs. Regarding the water resource, in food processing industries, water is one of the most important resources, this is one of the reasons why this location has been chosen for the project, since Lodosa is crossed and supplied by the river Ebro that crosses the town.

This chosen town has gained throughout its history a recognized prestige due to the good irrigation provided by the Ebro River and the development of agricultural activity intensified by the good work of the farmers of the area. As a consequence, Lodosa is getting fruits of excellent quality, among which there is the piquillo pepper native preserves that leads the production and gives its name to the Appellation of Origin that is included in the production of this project. The excellent quality of the products produced in this area has boosted the success of other businesses, emerging by this way a gastronomy, network of shops, hotel and catering establishments of high quality. All these aspects represent a social environment in which is viable to locate a fully optimized canned vegetable industry, where skilled labor will be found for the different phases of the project and help the town increase its income.

1.2. Climate and soil of the area

The village of Lodosa presents a Mediterranean-continental climate characterized by abrupt changes in temperatures, scarcity and irregularity of rainfall. As a consequence of the orientation of the Ebro Valley, the prevailing winds are those of the southwest, warm and humid, and those of northwest direction "cierzo". According to the climate classification of Thornthwaite, the climate type is semi-arid. It is not an area characterized by natural disasters of any kind. Average annual mild temperatures are recorded, between 12 and 14°C, with extremes of 1 or 2°C in winter and between 25 and 38°C in summer. Lodosa is a town in which there is not common to see any landscapes with trees since most of the plant territory has been dedicated to agriculture, leaving only 56 hectares of poplars and 32 hectares of reforested pine forests. The landscape of Lodosa is configured by different levels of terraces originated by the Ebro river. The highest heights are obtained on the right bank of the Ebro, at Monte Alto at 471 meters and at Homos at 451 meters.

Regarding the geomorphology of the area, the materials that appear are mainly silt and clay, as well as limestone and gypsum. The softest slopes of the terrain appear on the lower terraces of the Ebro, where the oldest and most productive irrigated fields are located. The rest of the territory presents slopes around between 5 and 10% where the highest terraces of the river are located. (Town hall of Lodosa, 2018)

1.3. Selection criteria related to the terrain

Regarding the selected land, Navarra is not among the autonomous communities with the most expensive square meter in the country since it is below Madrid, Catalonia, the Balearic Islands and the Basque Country.

One of the selection criteria referring to the terrain chosen to locate a project, are the neighbors in the neighboring plots. In this case, the plot selected for the production of the canned products is plot 270 of the industrial park 2 of Lodosa. Among the neighboring plots, only number 771 and number 811 are found, plots whose activity is not related to food. The rest of the companies located in the surrounding of the selected plot are mostly engaged in the production of canned vegetables, so they are not a problem when carrying out the activity.

As mentioned above, the case of the water resource is not a problem since one of the characteristics for which this town is known is for its high quality irrigation systems supplied by the Ebro river, which crosses the extension from side to side of Lodosa, separating its territory in two parts located on each side of the river.

As for energy resources, there is a high voltage line that surrounds the municipality of Lodosa and supplies it, as well as an underground line with several transformation centers.

The municipality of Lodosa has a Wastewater Treatment Plant (WWTP), so this type of waste with possible contaminant character and that is produced in the food processing industries is not a management problem in this case.

PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

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ANNEX 2. MARKET STUDY

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

March 2018

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1. Food industries

The food industries are an important source of income in most countries, they are in constant development and innovation as knowledge and technological development increases in the agricultural field.

1.1. World level

One of the challenges facing the food industry worldwide is to deal with a situation of overpopulation, taking into account that by 2050 it will demand 70% more food than at nowadays. The question is how to deal with a situation of 9,200 million inhabitants on the planet, exceeding by 38% the current number. For this reason, important companies in the sector such as Nestle have proposed to promote a healthy diet in the younger generations, especially to educate them for the future.

Regarding the situation of the food industry, in Europe represents the largest activity of the manufacturing industry, having 14,6% of sales together with a value that exceeds the number of 1,244,000 million euros. Europe has around 289,000 companies that employ 4,29 million people, representing almost 50% of sales within the agricultural sector. 95,4% of the companies are Small and Medium Enterprises (SMEs) with less than 50 employees and 78% of these with less than 10 employees.

1.2. National level

In Spain, the food and beverage industry is one of the first industrial branches, accounting for 20% of product sales, more than 18% of employed persons, 18% of net investments in tangible assets and 16% of added value.

Spain has around 28,000 food companies, representing 14% of the Spanish industrial sector. These companies employ more than 350,000 people (18% of the industrial sector), with more than 90 million euros in net sales (more than 20% of the industrial sector) and more than 19,000 million euros of added value. This last number represents almost 2% of Spanish Gross Domestic Product (GDP).

The activity groups with the greatest contribution to the total net sales of the industrial sector, in 2014, were Food and beverages (20,5%), Motor vehicles (12,5%) and Metallurgy and manufacture of metal products (11,4%).

In terms of the number of companies in the food industry, of the more than 28,000 companies that exist in Spain, the Bakery and pasta sub-sector occupies the first place with more than 36% of companies, followed by the Wines sub-sector and by last, followed by the meat industry. Taking into account the territorial distribution, it is worth highlighting Andalusia with more than 5,000 companies, followed by Catalonia, Castilla y León and Castilla la Mancha. (Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente, 2014)

2. Canned vegetables industry

2.1. World level

The European market for preserved fruit and vegetable production is the largest in the world, accounting for more than 40% of total imports. The volumes of importation of preserved fruits and vegetables are stable. The main import and consumption markets are Holland, Germany, France and the United Kingdom.

In the long term, it is expected that the European market for preserved fruits and vegetables will remain stable with respect to the continental types of fruit and vegetables. Great competences are

presented for developing countries if they focus on the commercialization of the most important products such as tomatoes.

However, the perspectives for tropical and exotic preserved fruits and vegetables are much more positive, providing greater opportunities for suppliers in developing countries. These products include preserved guava halves, mango slices or tropical fruit cocktails.

The main supplier of preserved fruits and vegetables from developing countries is China (mainly canned tomatoes, mixed vegetables and asparagus), followed by Turkey (olives), Thailand (pineapples) and Peru (mostly asparagus).

Suppliers from developing countries with the most significant growth in exports of canned fruits and vegetables to Europe in the last five years were Egypt (49% annual growth, mostly preserved tomatoes), Chile (40% mostly preserved tomatoes, blueberries and grapes) and the Philippines (13%, preserved pineapples).

For suppliers from developing countries, you can find opportunities to export preserved exotic fruits (guavas, mangoes, papayas, tamarinds) as these products they are imported increasingly. In Europe there is also a growing demand and increased imports of canned ginger, asparagus, artichokes, beans, corks and sweet peppers.

2.2. National level

The sector of canned vegetables in Spain is characterized by the stability of volumes and operators, with a strong dependence on foreign markets. It is a mature market with a sale in 2016 of around 6220 million euros and 1,5 million tons of production. It is a well-structured sector that exports around 50% of the production in volume and around 40% of its total turnover. The main areas of canned production in Spain are the area of Albacete, Alicante and Murcia. The area of Navarra, La Rioja and Aragon. The area of Valencia and Castellón. The area of Andalusia and the Extremadura area.

You can find fruit and canned vegetables within the preserved vegetables sector. In each sub-sector there are "star" products. On the one hand, in the case of preserved fruits, mandarins, peach and apricot stand out. In addition to the canned pears, strawberries and jams.

On the other hand, in the case of canned vegetables, the "artichoke", canned pepper and asparagus stand out among the "star" products. Regarding canned tomato, the concentrate tomato, the peeled tomato, the tomato juices and the crushed tomato are the most outstanding products.

The Spanish sector of companies that manufacture and sell preserved vegetables is made up of about 600 operators, although the lack of dynamism of domestic demand is causing some small groups to leave the activity every year and the concentration tends to be more pronounced. Currently, the canned vegetables market tends to be dominated by large groups of national capital together with multinationals.

The company that leads the sector has a turnover that is around 215 million euros per year, followed by the second group that invoices around 200 million euros. White brands control 79% of all volume sales of crushed tomatoes, and 72,4% in value. In the case of asparagus, these figures reach 57,5% in volume and 54,5% in value. The sector generates around 32000 jobs, assuming 9% of the total occupation of the Spanish food industry.

Table 24: Preserves vegetable industries (ALIMARKET,2015)

PRINCIPALES EMPRESAS DEL SECTOR DE CONSERVAS VEGETALES	
EMPRESA	**VENTAS Mill. Euros**
Conservas El Cidacos, S.A. *	215,00
Hero España, S.A. *	200,20
Grupo Ángel Camacho, S.L. *	196,70
Grupo Ybarra Alimentación, S.L. (GYA) *	180,00
Grupo Helios *	164,00
Juver Alimentación, S.L. *	155,31
Coop. Alimentos del Mediterráneo *	145,00
H.J. Heinz Foods Spain, S.L. *	144,00
Compre y Compare, S.A. *	115,00
Industrias Alimentarias de Navarra, S.A.U. *	110,56

2.2.1. Consumption

Regarding the consumption of fruit and vegetables processed in Spanish homes reached the number of 592,7 million kg of fruit and vegetables processed and spent 1,251 million euros in 2015. The most important consumption is associated with fruits and canned vegetables being these ones of 10,2 kilos per person and year.

Table 25: Consumption and expense in 2015 in Spain, (ALIMARKET,2015)

CONSUMO Y GASTO EN FRUTAS Y HORTALIZAS TRANSFORMADAS DE LOS HOGARES, 2015				
	CONSUMO		GASTO	
	TOTAL (Millones kilos)	*PER CÁPITA* (Kilos)	TOTAL (Millones euros)	*PER CÁPITA* (Euros)
TOTAL FRUTAS Y HORTALIZAS TRANSFORMADAS	**592,7**	**13,3**	**1.251,0**	**28,0**
FRUTAS Y HORTALIZAS EN CONSERVA	454,5	10,2	993,1	22,2
GUISANTES	9,4	0,2	21,4	0,5
JUDÍAS VERDES	11,9	0,3	17,0	0,4
PIMIENTOS	15,3	0,3	62,2	1,4
ESPÁRRAGOS	21,5	0,5	123,9	2,8
ALCACHOFAS	8,9	0,2	38,7	0,9
CHAMPIÑONES Y SETAS	18,1	0,4	50,3	1,1
MAÍZ DULCE	18,9	0,4	58,6	1,3
MENESTRA	4,6	0,1	8,2	0,2
TOMATES	241,2	5,4	319,3	7,2
TOMATE FRITO	172,2	3,9	239,6	5,4
TOMATE NATURAL	69,0	1,5	79,7	1,8
TOMATE NATURAL ENTERO	9,2	0,2	11,5	0,3
TOMATE NATURAL TRITURADO	59,8	1,3	68,2	1,5

2.2.2. Exportation and importation

The demands of the domestic market are not enough to absorb the volume of production of the Spanish sector of canned vegetables, so that exportations appear as an essential resource to maintain the current production volumes. It is considered that, in general terms, it is exported around 50% of the total volume produced, while in value its contribution exceeds 41%, with about 2900 million euros. Within the exportations stand out those of tomato, by a value of 322 million euros, in addition to the canned mushrooms with 50600 tons and 75,4 million euros; of artichokes with 28400 tons and 52,2 million euros; and corn with 26300 tons and 33,6 million euros.

The destination countries of this foreign trade, are mainly European Union countries, in the case of canned products from Murcia, exportations have as main objective the United Kingdom and France with market shares of 22% of total exportations.

Regarding the importations of raw material for the production of preserved vegetables, it comes mainly from China and Peru.

3. Pepper

The origin of the pepper is from South America, coming from the area of Bolivia and Peru. Currently, almost half of the world pepper production is from the Mediterranean area. It belongs to the group of vegetables that are produced in almost all parts of the world. The uses that can be attributed to the production of pepper are four: the fresh consumption, the preparation of pepper for paprika (obtained from the grinding of the husk), cultivation of spicy varieties and finally the production of canned peppers.

3.1. World level

3.1.1. Production

Worldwide, pepper is one of the crops that occupies the most surface within the species that grow protected crops under greenhouse. The first pepper producing country in the world is China with 16,000,000 tons. Taking into account FAO data, pepper production has undergone an increase in production over the years in a constant manner, thus obtaining a graph that represents it.

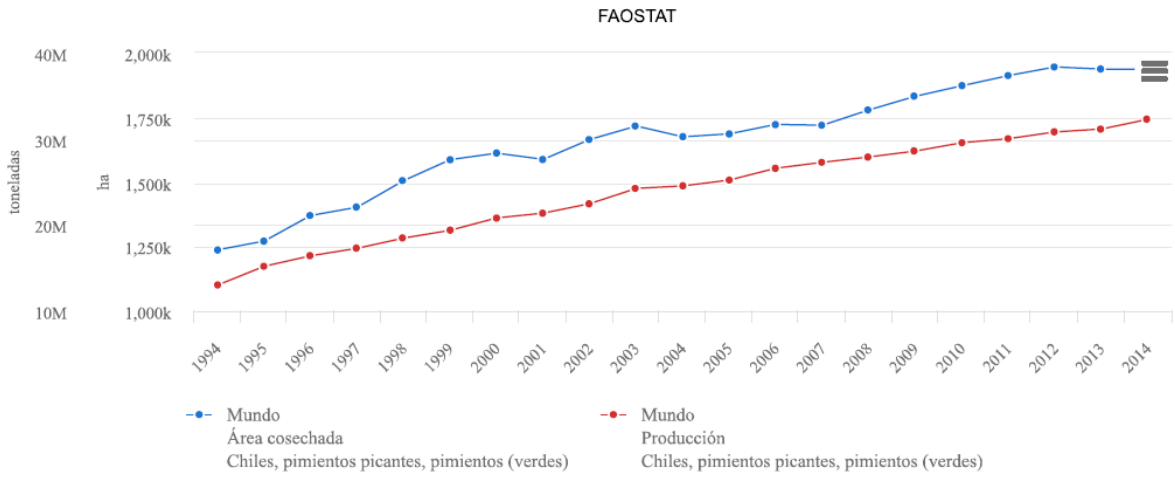

Figure 18: Pepper production at a world level, (FAO, 2014)

It is presented a figure divided into sectors that shows the difference existing worldwide in terms of production, with Asia being the leader with more than 60% of production worldwide.

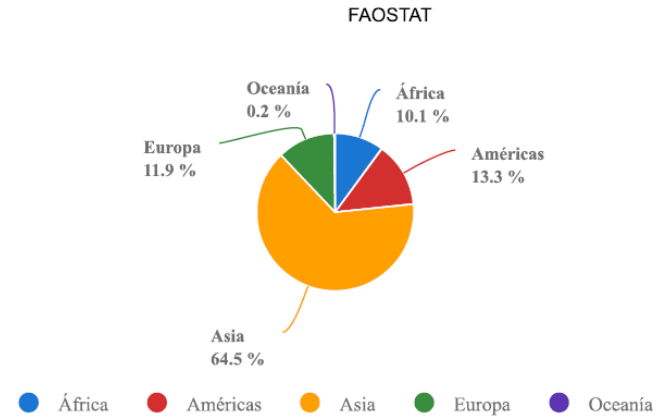

Figure 15: World production of pepper, (FAO, 2014)

It is presented a figure in which it can be observed the difference regarding the pepper production by countries. Spain, would be in fifth place, data taken from FAO.

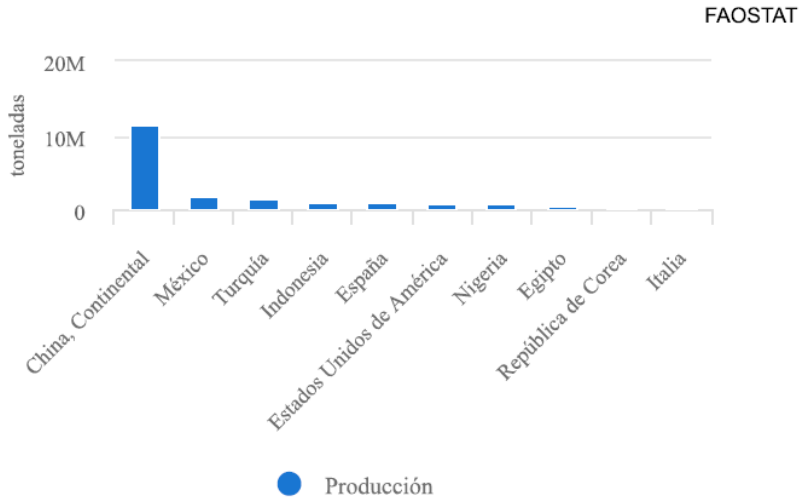

Figure 19 Pepper production by countries, (FAO, 2014)

3.1.2. Exportation

One of the main pepper exporting countries is Mexico and its main customer for this product is the USA. In Mexico there has been a boom of mini conical peppers (sweet bite), with integrated pest control of 20-25%.

In the framework of export of this vegetable, Spain has as customers Germany, France, Holland, United Kingdom and Italy. For this reason, Mexico is not a rival in terms of exports to other countries, having only one client. Within Spain, Almeria represents 69.08% of the country's export, followed by Murcia with 13.34%. Spain, in turn, is an important Moroccan customer in the pepper market, followed by France and Germany who also receive Moroccan pepper.

Regarding the Dutch pepper exportation, Germany, United Kingdom, the USA, Sweden and Poland are its main customers. Israel has Russia as its main customer, since half of its exports travel to Moscow.

Taking into account the different varieties, the piquillo variety of pepper is one of the most important. One of the main countries producing piquillo peppers and exporters of the same to other countries is Peru, which has as potential customers Spain, France, Italy and USA.

3.2. National level

3.2.1. Production

The pepper is one of the most important products in Spain, as it has been discussed above, the leading province in terms of pepper production is Almeria with about 69% of production followed by Murcia with just over 13% of the production. Almería adds an average production of 8 kg of pepper per square meter, while in Murcia you get figures of 11 kg of pepper for each square meter.

In the 2014/2015 campaign, Almería produced an amount of 640 million kilos of pepper, of which 500 million were of the California type. Of these 500 million, 425 were exported to the client countries of Spain.

Among all existing pepper varieties, piquillo peppers represent a great source of income. A part of the production is covered under the Appellation of Origin "Pimiento del Piquillo de Lodosa". This variety of peppers is grown in the southwest of Navarra and the production under the Appellation of Origin receives the name due to the geographic term of which is autochthonous, Lodosa. In addition to Lodosa, the following towns are within the regulations of the A.O: Andosilla, Cárcar, Sartaguda, Mendavia, Lerín, Azagra and San Adrián. This last campaign of the Piquillo Pepper of Lodosa has been qualified by the Regulatory Council as "good" since it has produced an amount of 1398 tons, 176 tons less than last year. The area cultivated this year has been 141 hectares, four more than last year.

3.2.2. Consumption

Taking into account the data obtained from the Spanish Federation of Associations of Fruit and Vegetable Exporting Producers (SFAFVEP) and exporting them to a representative graph, the evolution in the consumption of pepper in Spanish homes with respect to the rest of the important vegetables is as follows.

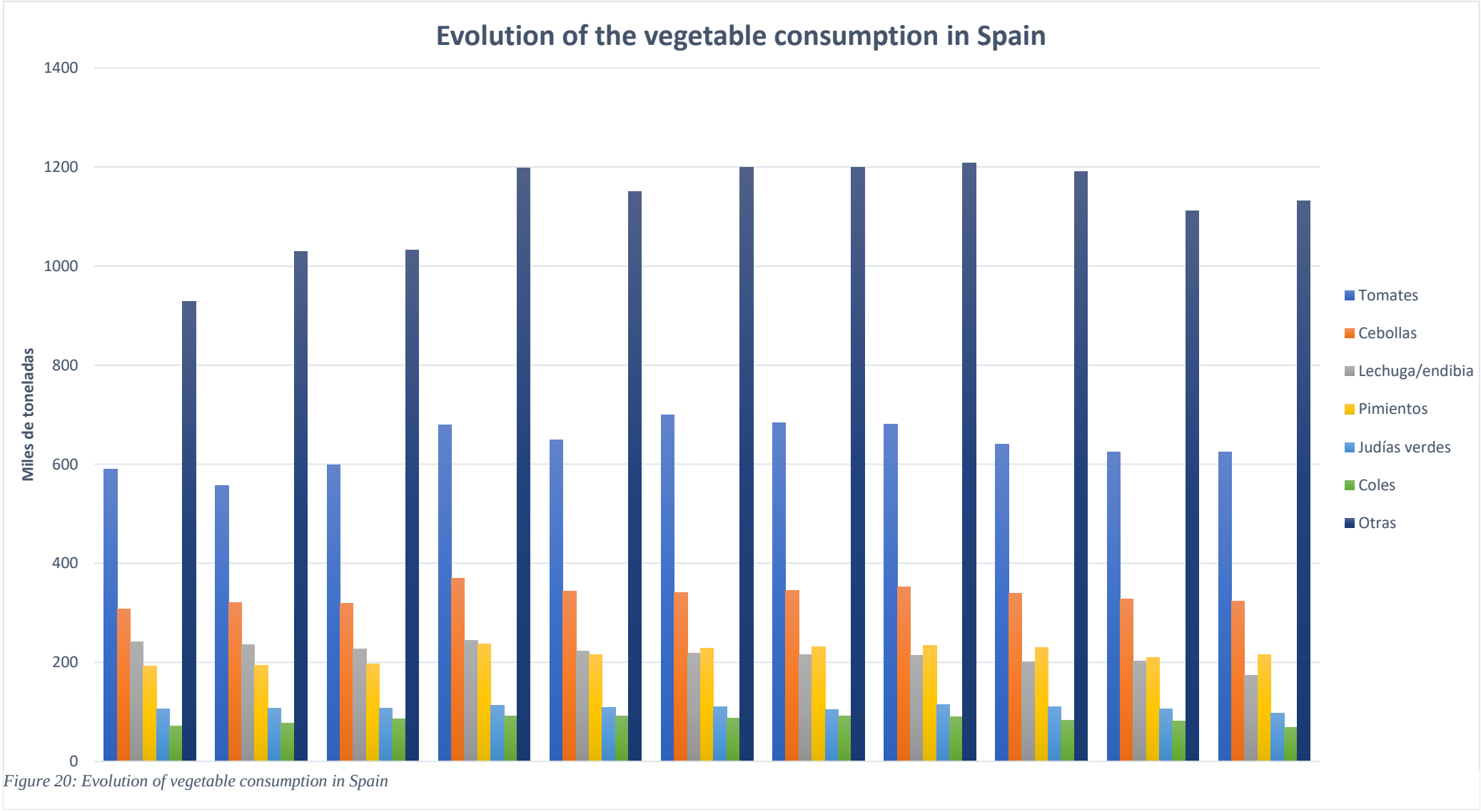

Figure 20: Evolution of vegetable consumption in Spain

As it can be seen in the figure, the most consumed vegetable in our country is the tomato with a clear difference over the rest of the products. The pepper represented by the orange color in the bar chart, would be placed in the fifth place in terms of most consumed vegetable. Isolating the pepper data to have a clearer view of the situation would leave a figure as follows.

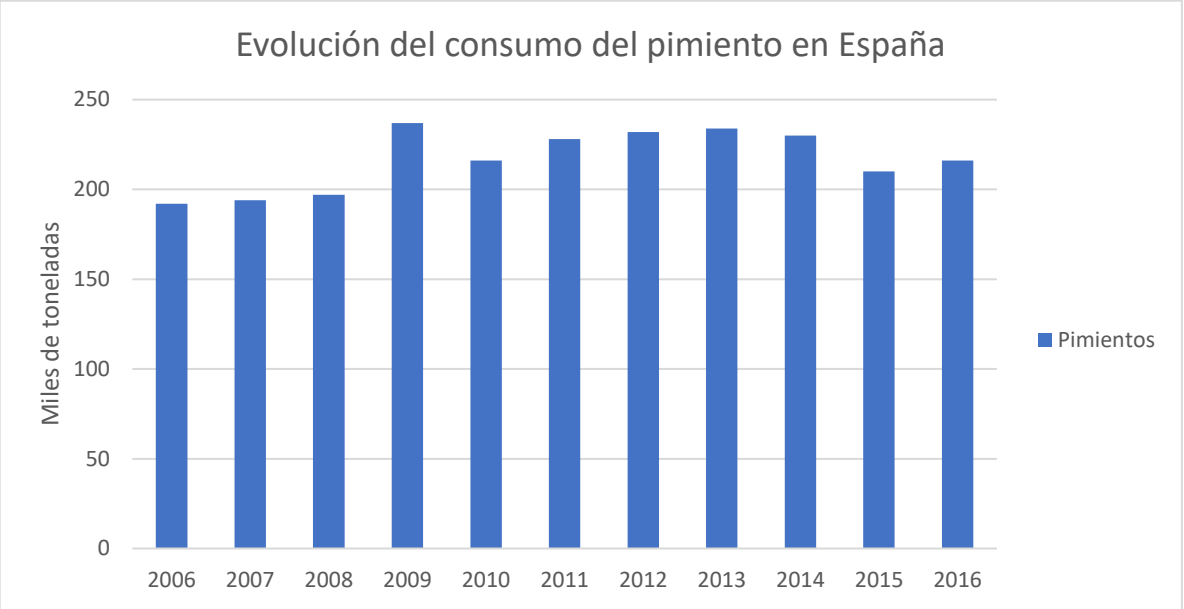

Figure 21: Evolution of the pepper consumption in Spain

As can be seen, the consumption of pepper in Spain has not suffered large variations, with 2006 being the year of least consumption and 2009 the year when most of the product was consumed. Consumption in Spain is characterized by not suffer large variations in terms of consumption figures although the price goes up or down. The differences in the diet in the different areas of Spain means that there are also variations in the demand and consumption of pepper.

4. Asparagus

The asparagus is a vegetable whose origin can be located in the Mediterranean basin as in Egypt appeared monuments with certain paintings in which bunches of shoots with two or three ligatures were appreciated. However, the first news about the cultivation itself is in the times of the Greeks. Some time later it was the Romans who distinguished the wild asparagus from the cultivated. The scientist and naturist Pliny the Elder, who died in the eruption of Vesuvius, related the medicinal virtues of asparagus and the exquisite quality of the asparagus grown in the gardens of Ravenna.

4.1. World level

4.1.1. Production

The production of asparagus is mostly located in Asia, since taking into account FAO data the leading country in production of this vegetable is China with more than 5 million tons a year. Being the second country Peru with less than 300 thousand tons a year. Spain would be in sixth place with more than 57 thousand tons a year. Taking the data from 1994 to 2014. This distribution is represented by the following figure.

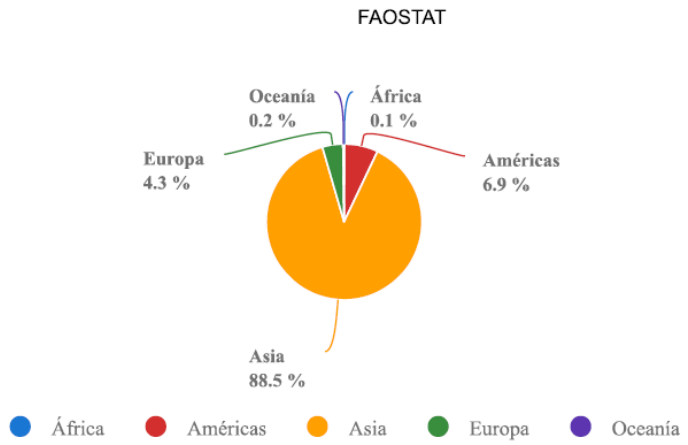

Figure 22: Asparagus production by countries, (FAO, 2014)

As it can be observed in the figure the clear differences between different continents when producing this vegetable. Asia being the world leader with 88,5%. A figure showing the progression of asparagus production worldwide is presented.

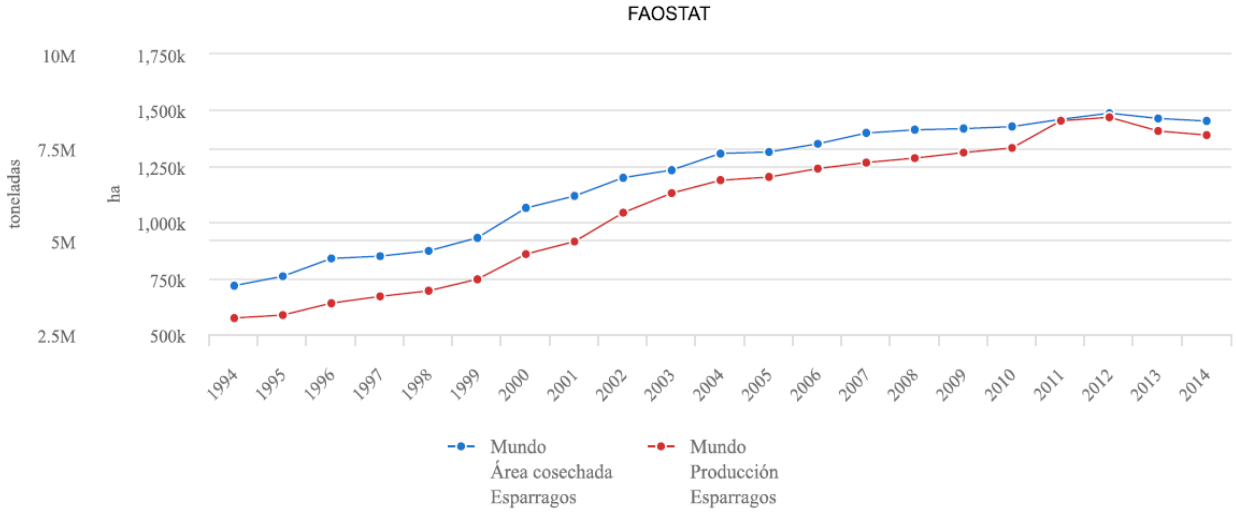

Figure 23: Asparagus production at a world level, (FAO, 2014)

As it can be seen in the figure obtained from the FAO, the trend in production and area harvested asparagus is growing worldwide, reaching more constant levels in recent years. There are no peaks in any productive period of this vegetable.

4.1.2. Exportation

If the three ways to commercialize the vegetable are differentiated, they would be fresh, preserved or frozen, the leading country in exportations of frozen asparagus is China with more than 80 thousand tons per year followed by Peru with more than 39 thousand tons per year. Peru would rank first in exports of fresh asparagus.

Within the European asparagus market, the main importing countries of this vegetable from countries outside the EU are: Holland, Spain, United Kingdom and Germany. The main non-EU suppliers are Peru, Hungary, South Africa and the USA.

The United Kingdom, not being a producer of asparagus, imports this product throughout the year from supplier countries that have been mentioned previously, such as Peru, the US or Thailand.

You can also see differences in tastes within a country, for example, German consumers prefer canned asparagus than frozen, a product preferred by the French.

4.1.3. Consumption

The asparagus market consumers, taking into account the two modalities "green" and "white" differ in the following two groups:

- Green: Spain, France, England, Holland, Denmark and Italy
- White: Germany, Holland, France, Switzerland and Austria

The white asparagus consumer market is stable in terms of quantities and dates of production. In addition, the edaphic characteristics necessary to carry out the production of white asparagus allows us to predict an increase in area in the future in Spain, since the Southwest of Andalusia has an abundance of this type of soil (sandy loam texture).

4.2. National level

4.2.1. Production

Despite the fact that Spain is one of the largest producers of asparagus worldwide, it imports from other countries such as Peru or China, since in these cases products are obtained at a price with which the national asparagus have no competition. This is due to differences in costs such as labor. A figure showing the progression of asparagus production in Spain is presented.

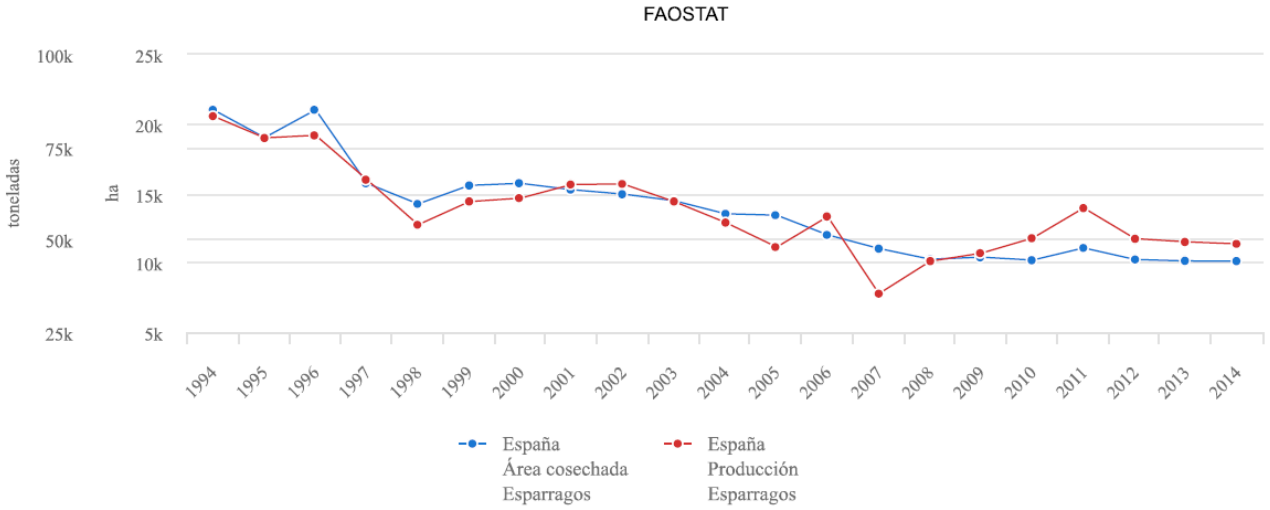

Figure 24: Asparagus production at a national level, (FAO, 2014)

As can be seen in the figure above taken from the FAO database, the production of asparagus in Spain in the period 1994-2014 follows a downward trend with some interesting peak. For example, it can be observed in 1995 a drop in production that was maintained until 1998 where a significant increase can be seen. Production follows a more or less constant trend until reaching the year 2006 in which it suffers again a significant decline that lasts just over a year. These differences between years may be due to climatic difficulties suffered during those years, such as droughts or floods.

4.2.2. Exportation

Regarding the commercialization of the asparagus, it must be taken into account the great expansion that takes place in Andalusia that is due to the marketing possibilities of a product intended for fresh consumption. This allows enter without problems in European markets, such as Germany.

It should be noted that, despite the fact that the USA is one of the major producers of this product, Spain does not import asparagus from there. However, Spain as a producer does export significant quantities to other countries belonging to the European Union.

Within the asparagus exports carried out by Spain, more than 85% are due to the exportation of fresh product, followed by 10% of canned product and the rest frozen product.

PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

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Agri-food & Rural Environment Engineering

ANNEX 3. RAW MATERIAL ANALYSIS

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

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1. Raw material

The raw materials that will be used to produce the two different canned products in this industry can be divided into main and auxiliary raw materials. Both are described in the following points.

1.1. Principal raw material

1.1.1. Pepper

Origin

All species belonging to the genus *Capsicum* come from America. Depending on the variety the origin is one or the other. For example, the associated wild species, *Capsicum cardenasii* and *Capsicum eximium* grow in dry habitats in Bolivia and Argentina. The *Capsicum annuum* group of white flowers, associated with more humid habitats, seems to have been originally distributed through the tropical lowlands of South and Central America.

Taxonomy and morphology

The pepper belongs to the family *Solanaceae*, the species *Capsicum annuum* L. The pepper is a perennial herbaceous plant with an annual growing cycle , reaching lengths of almost 2 meters.

The root system consists of an axonomorphic root (pivoting) from which a set of lateral roots that can reach a length between 50 centimeters and 1 meter. The weight of the root system is only 7 to 17% of the total weight of the plant depending on the variety that is being studied. There are differences between the relative proportion of the root system and the rest of the biomass of the plant between young plants and adult plants, being higher in the first ones. A good development of the root system is one of the most important aspects when carrying out the cultivation, since carrying out good techniques of fertilization, irrigation and other necessary work will obtain better productive results.

Within the development of the stem and the branches three distinct phases can be distinguished: development of the seedling up to the first branch, phase of rapid development of the buds and formation of flowers and phase of slow growth and development of the fruits. Once the three phases are finished, a stem with limited growth and erect character is obtained. At the moment that the stem acquires a certain height, the branching begins in a dichotomous manner that will last until the end of the plant cycle. The stem carries out certain very important functions within the development of the plant, such as, for example: mechanical support of the plant, transport of crude and processed sap, synthesis of phytoregulators, as well as other metabolic functions.

The pepper has simple leaves, lanceolate and with a long petiole that joins the leaf with the stem and the expanded part, leaf blade or limb. The beam is smooth and smooth, the color of it varies according to the variety of pepper that is studied. The main nerve leaves the base of the leaf and from which different secondary nerves disintegrate. The leaves follow an insert in the alternate stem and the size also varies depending on the variety of pepper.

The flowers of the pepper are hermaphroditic, since they produce both male and female gametes. The forms that have been domesticated from some of the varieties such as *Capsicum annuum* or *Capsicum frutescens*, the leaves appear solitary in each of the knots. However, there are certain exceptions, within the *Capsicum annuum* variety, there are populations in which the flowers appear two by two or in more numerous clusters. The flowers are attached to the stem by a peduncle or pedicel of a length between 10 and 20 mm. Each one of the flowers is constituted by an axis or receptacle and foliar appendages that constitute the different foliar parts, being these: the calyx that has the shape of a bell with 5 to 8 sepals, the corolla with the shape of a wheel or bell and has 5 to 8 petals, the androceo with 5 to 8 stamens and the gynoecium with 2 to 4 carpels. You can represent that information with the following floral formula:

K (5-8), [C(5-8), A (5-8)] G (2-4)

In most varieties of pepper, the fruit is the most important element from the economic point of view, except for some variety of ornamental interest, in which the whole plant matters. The fruit develops from the gynoecium of the flower. The fruit of the pepper is a berry, hollow, full of air and shaped like a capsule. The size of the same varies and can weigh between a few grams to 500. The seeds are rounded, they are on the surface of the placenta. The surface of the seeds is relatively smooth, without pubescent or tomentose appearance. The weight and size of the seeds is related to the weight and size of the fruit.

Image 11: White pepper flower, pepper in plant and pepper fruit

Physicochemical aspects

The chemical composition of the pepper for each 100 g of product, in this case of the sweet pepper is the following:

- Dry matter (%): 8,0
- Energy (kcal): 2,0
- Protein (g): 1,3
- Fiber (g): 1,4
- Calcium (mg): 12,0
- Iron (mg): 0,9
- Carotenes (mg): 1,8
- Thiamine (mg): 0,07
- Riboflavin (mg): 0,08
- Niacin (mg): 0,8
- Vitamin C (mg): 103,0
- Average nutritive value (ANV): 6,61
- ANV per 100 g of dry matter: 82,6

In addition, within the composition of the peppers, are the pigments. These can be divided into three groups, which are the following:

- Main or characteristic pigments: Capsantin and capsorubin are in charge of providing the fruit with red color.
- Pigments with provitamin effect: Criptonxanthin and beta-carotene.
- Other carotenoid pigments: Zeaxanthin and lutein.

Firstly, the physicochemical aspects are those that are most related to the conservation process that is going to be applied. First, it should be noted that the pH of the product is between 3,8-4,5. Thus, citric acid is applied to acidify the canned products so that the treatment that must be applied is softer than a sterilization.

Secondly, based on respiration and ethylene production, the fruits can be classified as climacteric or non-climacteric, with the former showing a large amount of ethylene and CO2. In the case of pepper, it can be categorized as partially climacteric since the ethylene content doubles when the fruit changes from green to red. However, the climacteric changes are not as pronounced as in the other members belonging to the Solanaceae.

Pests and illnesses

Among the main pests that can attack the pepper crop are the following insects: thrips, aphids, mites and caterpillars.

Pests

Firslty, the thrips are a pest that is conditioned by the good temperatures and distributed by the coastal areas of the Iberian Peninsula, as well as the entire surface of the Canary Islands and the Balearic Islands. The damage produced can be based on feeding bites and cracks or by injection of Tomato Tanning Virus or Tomato Spotted Wilt Virus (TSWV). The bites are carried out with the aim of sucking the nutritive solution from the stem or leaves. These slits are first empty and then filled with air, thus acquiring a silver color. The depreciation of the product depends on the state of the fruit in which it is harvested, greener or redder.

The most abundant trip species is the *Frankliniella occidentalis* (Californian thrips), introduced in Europe from California and quickly integrated into Spain. The characteristics of the adult are: they measure between 1 and 1.5 mm in length, yellowish or brown, they have two pairs of feathery wings and it is characterized as a flying-jumper.

The control of this pest can be carried out using chemical or physical methods. The opinion about each method depends on each producer, there are those who rely on chemical methods, while others defend that this plague is capable of recovering from this action evolving against it. These bet by the physical methods applying antitrips meshes and sticky substances.

Image 12: Triph and the damage the produce to the pepper

Secondly, the aphids, the presence of this pest in the pepper crop is systematic and the damage that can cause is very important in production. These insects cause curls and embossments in the leaves, also cause bold on the segregated molasses. Indirectly they are transmitters of the Cucumber Mosaic Virus (CMV) and Potato Virus Y (PVY) virus that affect pepper.

Among the different species of existing aphids, those that attack the pepper crops are usually *Myzus persicae*. The winged females found the colonies that in a few days will constitute important foci of the plague that, in turn, will be dispersed again by winged specimens.

This pest type is characterized by rapid diffusion and development throughout the crop, for this reason it is considered positive control of the pest based on chemical treatments. Among the products allowed are acephate or pirimicarb. In addition to chemical treatments it is also necessary to always take into account the natural enemies and the auxiliary natural fauna.

Image 13: Aphids and the damage the produce to the pepper leaves

Thirdly, the mites, there are two different types of mites that usually attack pepper crops: the red spider or *Tetranychus urticae* and the white spider or *Polyphagotarsonemus latus*. The red spider develops on the underside of the leaves causing discoloration and general yellowing of the leaves that, if the attack is considered very aggressive, the leaves end up falling. The white spider causes damage to the adult leaves, such as the ripple of the nerves in the apical leaves and the desiccation of the younger shoots.

The control of both species is based on the use of chemical products, although the biological control is gaining importance in both cases.

Image 14: Red and white spider in pepper plants

Finally, the carterpillars the cultivation of pepper can be attacked by different species of caterpillars, among which are: *Spodoptera exigua, Heliothis armigera, Chrysodeixis chalcites or Autographa gamma*. The damages that produce in the crops are based on the bites to the fruits or vegetative organs. The consequences can be considered serious in the first stages of vegetation.

Among the different preventive methods are: placement of meshes in greenhouses, pheromone traps and light or cleaning of weeds. In addition, biological control can be considered by applying a larval pathogen such as *Bacillus thuringiensis*.

Illnesses

Apart from the damage caused by pests, we must take into account the damage caused by fungal, viral and bacterial diseases.

Within the fungal diseases can be differentiated, those produced by soil fungi or those produced by aerial fungi.

Soil fungi

One of the soil fungi that produces this type of disease in pepper crops is *Phytophthora capsici* that can attack different horticultural species. The attack can be carried out in any vegetative state, both in the young plant and adult, being the period of formation of the fruit a critical period before this threat.

The symptoms can be perceived from the neck of the plants presenting there a dark spot where the sap is interrupted and a wilting of the premature plant takes place. The infection of the plant begins in the root system, from which it is gradually opening step towards the main parts of the plant. We must be very careful with this type of infection because as it is a fungus soil, if splashes of soil contaminated by dripping or droplets of water can occur propagation in fruits and different parts initially unaffected.

The causative agent of this infection, as previously mentioned, is *Phytophthora capsici*. Their multiplication organs have the property of forming zoospores that are responsible for initiating the infection.

The prevention of this infection is possible, while curing it is practically impossible. To reach prevention, treatment with fungicides has to be applied before infection. As complementary measures to take into account are presented: do not repeat the cultivation of pepper in areas of high risk of infection, always use healthy plant, water with well water or prevent irrigation water from reaching the neck of the plant.

Image 15: Phytophthora capsici in pepper

Aerial fungi

One of the fungi that has the ability to infect the pepper crop in its aerial organs is the species *Botrytis cinerea*.

This species of fungus can behave either as a parasite or as a saprophyte, causing major damage, especially in greenhouse crops, since its optimum growth temperatures are between 15 and 20 °C and relative humidity around 95%. This type of fungus can attack stems, leaves and fruits, in which it causes spots and rotten areas.

To control this type of fungus, preventive measures must be applied, such as, for example: adequate management of ventilation and irrigation, removal of crop remains and plants that are diseased, and appropriate planting frames to be able to ventilate the cultivation.

For an effective control, it is good to also take into account the chemical methods complemented with the preventive measures mentioned in the previous paragraph. It should be noted that this type of fungus has the ability to create resistant strains, for this reason it is advisable to vary the products applied and not always use the same active ingredients.

Image 15:Botrytis cinerea in pepper

Viral diseases

The pepper culture has been one of the most affected by viral diseases in recent years, being affected by viruses transmitted mechanically or through different types of insects (aphids or thrips).

The virus transmitted by aphids is the Cucumber Mosaic virus, whose symptoms begin with a diffuse mosaic and chlorosis. In addition, it produces ripple in the nerves, narrowing and distortion of the leaves. There are more than 75 different agents of virus distribution and transmission can be considered extremely fast. Another virus that follows the same transmission scheme as the Mosaic virus of the cucumber is the Y virus of the potato, which causes a typical mosaic with dark vein banding in the leaves.

As for the virus transmitted by thrips, it is the Tomato Tanning virus, which causes considerable economic losses in the production of the pepper crop. Symptoms vary from one situation to another, sinuous lines, arabesques, and ringed spots, or even necrotic spots and apical death may appear.


Image 16: Pepper mosaic and Tomato Tanning virus

Bacterial diseases

Regarding bacterial diseases, although in Spain there are certain bacteria capable of damaging the pepper crop, these types of diseases are sporadic, occurring in specific temperature and humidity situations.

The bacteria capable of causing damage to the pepper crop are: *Xantomonas campestris* p.v. *vesicatoria, Clavibacter michiganensis* sub. *Michiganensis* and *Erwinia carotovora*.

To avoid diseases of a bacterial nature, preventive measures to be implanted in the crop are more important than chemical methods. Among these measures are: Use healthy seeds, avoid high levels of humidity and destroy diseased plants.

1.1.2. Asparagus

Origin

Asparagus is one of the horticultural crops of which there are older references, on the one hand, it is said to come from the Mediterranean basin, while others claim that it comes from the British Isles. It is probable that the cultivation began its development in the regions of the Middle East. Alexander the Great discovered it in his conquests and was responsible for its introduction in Greece. Some time later the Romans adopted it, of which there are writings with methods for the cultivation of asparagus. The Arabs were in charge of introducing this plant in Spain. (Rigau, 1988)

Taxonomy and morphology

There are several species of asparagus, among which are those that have an edible use and those that have a decorative use only. The species of asparagus cultivated today is a perennial plant, which belongs to the *Liliaceae* family and whose scientific name is *Asparagus officinalis* var. *altilis* L.

This species is currently cultivated, however, there are other species that are not cultivated, but have an edible use and are the following: *Asparagus acutifolius, Asparagus temifolius*, *Asparagus albus* L, *Asparagus Scaber* L, *Asparagus horridus* L, *Asparagus aphylus* L. All these last mentioned species are known in Spain for wild asparagus.

The root system is formed by a rhizome or underground stem with radial growth. This system carries with it buds that sprout from the top of this rhizome and roots that are born from the lower and lateral part of the rhizome. The rhizome is the perennial part of the plant, in which substances such as starch and certain nutrients accumulate. The growth that follows a rhizome is of horizontal type and carries with it scaly leaves to part of the yolks and roots that already have commented.

The root system consists of two types of roots, thick and thin. The fine roots grow adventitially or secondarily from the base of the rhizome. These roots are cylindrical with a diameter between 2 and 3 millimeters. These roots do not have any branching and can reach a length of 2.5 meters in length. This type of roots of fleshy character has as a function the storage of reserve substances such as carbohydrates, proteins and minerals.

The fine roots are born from the base of the rhizome and wrap around the thick ones. This type of roots are fibrous unlike the previous fleshy type, their growth is vertical type and can reach a depth of up to 4 meters. The main mission of this type of roots is the absorption of water and mineral nutrients so as to incorporate them into the plant. Sprigs of new rootlets appear every spring. One of the characteristics of this crop is that the root system represents a large part of the whole of the plant in terms of weight, since in the first years of planting the weight of the root system resembles that of the aerial part of the plant.

In the crown of the rhizome (underground stem) are forming buds continuously, from which buds will sprout. These turions, will form the edible and marketable part of the asparagus.

The leaves in this type of crop are rather branches that take the foliaceous form of the leaves and carry out the functions of them within the cycles of the plant.

Asparagus is a dioecious plant, that is, it only has individuals with male flowers or individuals that only have female individuals. The male flowers are greenish-yellow and flower in groups of 1 to 4 elements in the armpits of the branches and they do it in the shape of a bell. They are more showy than the female flowers and bloom before them. The female flowers are smaller and are characterized by having a very developed pistil. They are white and they are the ones that produce fruits.

The fruit of the asparagus plant is a round berry, green at first and then red at maturity. Inside you can differentiate 2 or 3 compartments in which we find a seed in each.

The seeds of this plant have an ovoid shape with a diameter between 2 and 3 millimeters. The yield of the seed is related to the diameter of the stems, the greater the diameter thereof, the greater the production of seeds.

Image 17: White turions and asparagus leaves

Physicochemical aspects

- Energy (kcal): 18,0
- Protein (g): 2,7
- Carbohydrates (g): 1,1
- Fiber (g): 1,5
- Calcium (mg): 22,2
- Iron (mg): 1,1
- Magnesium (mg): 11,0
- Zinc (mg): 0,3
- Sodium (mg): 4,0
- Potassium (mg): 207,0
- Phosphorus (mg): 59,0
- Thiamine (mg): 0,12
- Riboflavin (mg): 0,13
- Niacin equivalents (mg): 1,4

The rest of the chemical composition corresponds to the water content of the product. In this case, around 94.7 g per 100 g of product.

Regarding the physicochemical aspects to be taken into account, white asparagus present a higher pH than in the case of pepper. The pH is between 4-6, for this reason, the heat treatment to be followed should be stronger than a pasteurization, so a sterilization will be necessary.

As for the production of ethylene, it is categorized as a non-climacteric vegetable since it is a very low production.

Pests and illnesses

Pests

Pests in a crop are the damage that animals produce in them and are classified according to the damage they cause and how they cause it. Taking into account this differentiation, different groups of pests are obtained in crops: chewers, suckers, miners and drills. (Rigau,1988; Serrano Cermeño, 2003; Pollock, 2010)

The chewing insects, as the name implies, cause the damage by chewing the plant material of the plants. In the cultivation of asparagus we find the following chewing insects within the set of their pests:

- Gray worm
- Spodoptera
- White worm
- Wireworm
- Heliotis
- Plusia
- Gardama
- Lepidoptera, polyphagous

The sucking insects cause damage to the plant by sucking the sap from its beak into the stem and leaves: Among the species that cause this type of damage are thrips and aphids.

The drilling insects cause the damage by perforating the stems and creating galleries in them, in this way they can end the life of the infected stem. In this set of species are the "Asparagus Taladro" and the "Fly of the asparagus". Next, some of these species are described.

Firstly, the Asparagus criocero, regarding the morphology of this chewing species, the adult individual is an elongated beetle about 6 millimeters long with a bright blue head, with small yellow, red and black spots. The larva is grayish in color with three pairs of legs well developed and black.

This species carries with it two generations of individuals a year, although if it is in a warm climate more of these two generations can be obtained.

As for the damage they cause, adult individuals do not cause too much damage to the plantation even though they chew leaves and stems. However, the larvae are responsible for causing damage of great importance in the production since they gnaw the bark of the stems and devour the leaves of the asparagus, also called cladiodes. If the attack on the plantation is very strong, the root system is very affected and weak.

Regarding treatment in the plantation, the appropriate time to treat this type of pest is 3 or 4 days after having observed the first larvae in the crop. Depending on which climatic zone the dates vary. An appropriate method is if plants with affected shoots are observed at the time of harvest, it is considered convenient to leave affected plants on the edge of the plantation to attract insects there and eliminate them with insecticide products.

Image 18: Asparagus criocero

Secondly, the fly of the asparagus, the adult individual is a fly of 6 to 7 millimeters, the thorax is light gray with 3 longitudinal black lines, the head is yellow and the legs are gray, the abdomen is black. The larvae are whitish, from 7 to 9 millimeters in length.

The optimal development temperatures of this pest are between 15 and 20 °C, if the temperature is below 15 °C they are practically without activity.

The most important damages caused by this type of pest are observed in the stems losing the ability to develop drying before branching. In addition, the galleries that form in the stems prevent the sap from circulating properly, thus ending the life of the affected stem. In young plants, the appearance of the insects coincides with the sprouting of the shoots that are affected and do not develop completely.

Regarding the treatments to be followed, since the laying is carried out on the terminal buds, it will be necessary to treat the shoots when they reach 2 to 3 centimeters in length. There are different insecticides to control this pest, among which are: Chlorpyrifos, Teglutrin and Trichlorfon.

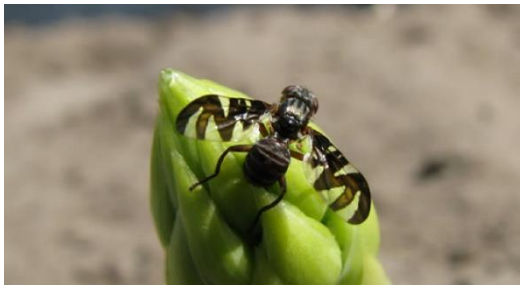

Image 19: Fly of the asparagus

Thirdly, the Asparagus Taladro, the Asparagus Taladro is a noctuid lepidopteran, the butterfly or adult individual has a dimension of between 35 and 45 millimeters, they have white forewings, with a wide spot in the posterior third, the hind wings are gray and their abdomen is covered by gray hair.

In its final development, the caterpillars have a length of between 50 to 150 millimeters, of ivory color and with the yellow head.

This species has only one generation per year, the adult has a very short life, around 5 or 6 days. The females deposit the eggs in the neck of the stems, under the surface of the soil, a female can lay about 100 eggs.

Regarding the damages caused in the crop, the root system is the one that is affected, destroying the buds of the rhizome and penetrating inside the fleshy roots. The plants end up dying in the course of their vegetative development.

Regarding the treatments to follow for the control of the pest, the same day that the harvest ends, a work of rotovator about 10-15 centimeters deep must be applied above the ridge. As in the previous case there are different insecticides to control this pest, such as, for example: Carbaril, Chlorpyrifos or Esfenvalerate.

Image 20: Asparagus Taladro

Fourthly, the wireworm, this insect is a coleoptera, whose adult individual is characterized by being elongated, brown, with the abdomen with striae on the dorsal side. The larva has a cylindrical shape, is golden in color and very hard.

The damage caused by this plague in the asparagus crop occurs both in the rhizome, causing major damage, although it is not seen since it is the underground part of the plant and in the stems creating the same galleries as in the rhizomes. The problems are observed at the time of harvest, since the perforations occur at the base of the shoot.

The insecticide products that exist and are authorized to control this pest are, as in previous cases, Chlorpyrifos and Tefluthrin.

Image 20: Wireworm

Finally, the white worm, this species is also a coleoptera as in the case of the wire worm and the adult individual has a length of between 2 and 3 centimeters. The head has a black color and the rest of the body is brown. The larva, however, is whitish in color, with an arched shape, with the posterior end of the abdomen black. The head of the larva is strong with jaws also with great force.

The evolutionary cycle of this plague is 3 years, being the second year the most problematic for the cultivation of asparagus. The damage is caused in this case by the caterpillars, as mentioned in the second year of the evolutionary cycle, biting the roots and rhizomes. As in all cases, the wounds produced can be the gateway to certain fungi causing diseases such as Fusarium and Rhizoctonia.

Image 21: White worm

Illnesses

Within the set of fungal diseases that affect the asparagus are two large groups, diseases that affect the aerial part of the plant and diseases that affect the set of underground systems.

In the first place, the diseases caused by fungi that affect the aerial part of the asparagus plant are: Rust, Estenfiliosis, Phytopthora and Cercospora. These diseases in particular are characterized by being easy to control, and although the affected plants can not be eliminated, the affected aerial vegetation can be destroyed.

Second, the diseases that cause damage to the underground part of the plant (rhizome, roots) include Fusarium and Rizoctonia. This type of diseases, unlike the previous case, are very complicated to control, for this reason it is very important to pay maximum attention to the soil where the plantation will be carried out. Next, a disease of each type is described.

Firstly the rust, The rust (*Puccinia asparji*), is a disease caused by a fungus *Basidiomycete* that develops in the aerial part of the plant. The symptoms observed in the affected plant can be separated into three phases with different symptoms.

In the first place, the first symptom appears in the spring season in which the basidióspores (spores formed by *basiodiomycete* fungi) intervene. This symptom consists of the appearance of lesions of an oval shape, of a light green color, in the center of which a golden color appears.

The second symptom is caused by the appearance of another type of spores, the eciuspores, which are dragged by the wind and contaminate other plants. These spores develop as they develop called uredospores. This process causes in the asparagus plant the appearance of blisters that break the epidermis of the stems.

Finally, the third symptom appears in autumn, is characterized by black spores, the teleuto spores.

The damage caused by this fungus in the production of asparagus can become catastrophic if it is not controlled in time as it completely paralyzes the crop's vegetative cycle and even attacks the reserve areas of the affected areas.

Regarding the treatments to follow to control this pest, it is very important to apply as many preventive treatments as necessary since once the spores are germinated and the disease is developing, its control is much more complicated. For this reason, it is very important that the spores be inhibited by the appropriate fungicide before germination.

This type of disease can be endemic in certain regions, in these areas, preventive treatments should be applied every 15-20 days, starting from the month of March until the end of its vegetative cycle. The treatments to be applied vary depending on the climatic conditions, if the application season has been rainy and the leaves of the plant have undergone important washes, systemic treatments will be applied. While if the time has not been rainy contact treatments will be applied. The contact fungicides are those treatments that once applied remain outside the leaves of the plant and prevent the development of the spores. With time and the action of water, these types of treatments lose effectiveness. The systemic fungicides are thought to act at the moment in which the plant is affected or when the climatic conditions for the propagation of the fungus take place, unlike the previous case that are characterized as being preventive. In systemic fungicides, the product through the plant penetrates and attacks the fungus.

Image 22: Rust in asparagus

Secondly, the fusariosis, it is caused by different types of Fusarium fungus, which are the following: Fusarium oxysporum f. sp asparagi, Fusarium moniliforme and Fusarium roseum. Each of these three agents attacks the plant in a different way.

First, the Fusarium oxysporum f. sp. asparagi is a fungus that produces a yellowing and withering in plants, in the root system produces necrosis in an oval shape and that develops until it manages to destroy the root, thus weakening the affected plants.

This type of fungus is able to produce the total death of the affected plant and thus end up with the complete planting of a esparragal. Once the crop is eliminated, the soil continues to be contaminated and the cultivation of asparagus is impossible in the future. The transmission of the disease from one plant to another can occur through the roots, the implements used and the harvesting blades used in the work of cultivation. It is considered a disease with difficulty when it is controlled by chemical products.

Secondly, the Fusarium roseum is a fungus that sits on the bases of the stems, giving rise to rotten areas that acquire reddish colors. Inside the stems, the tissues are affected taking also a color between pink and reddish. This disease occurs when the plant is stressed by high or low temperatures, in addition, if a situation of high humidity is reached, the disease is also favored to its development.

Finally, the *Fusarium moniliforme* is related to the attack on the rhizome and the base of the stems and not so much with the attack on the roots. At present and due to the type of fungi that are being treated in this case, the best method to treat this type of diseases is the use of varieties tolerant to the fungus Fusarium and carry out cultural procedures that ensure the vigor of the plants.

Image 23: Fusariosis in asparagus

1.1.3. Water

The water is part of the government liquid inside the canned products, which has the following functions:

- Improve heat transmission to solid portions of food
- Displace the air in the containers
- Improve the taste and acceptability of food
- Acts as a distribution medium for dyes and flavorings.

The water destined to food production in the food industry is governed by Royal Decree 140/2003, of 7 February, which establishes sanitary criteria for the quality of water for human consumption, which exempts from this legislation that water supply in the food industry that ensures that

its health does not affect the quality of the final product. As in this case, the sanitation and hygiene of the water that is going to be used in this food industry directly affects the microbial growth and the risks to which the products are exposed, that industry must comply with this decree.

1.1.4. Additives

Firstly, the concept of additive is defined according to the Codex Alimentarius, in 1963, as follows:

"A food additive is any substance that is not normally consumed, even if it is of a nutritional nature and is not normally used as a characteristic ingredient of a food; Whether or not it has nutritional value, it is intentionally added to a food with a technological or organoleptic purpose, at any stage of manufacture, transformation, treatment, conditioning, packaging, transport or storage of the said food and that may affect or affect (directly or indirectly) their incorporation or that of their derivatives in the food or may otherwise affect the characteristics of said food. The expression does not apply to contaminants or substances added to food so as to maintain or improve their nutritional properties " Multon,mVillanúa Fungairiño, y Valle Vilanova, 2000).

The study of additives leads to the need to classify them, and one way to do this is to separate them into groups based on their chemical functions. The categories of additives according to their chemical functions are the following:

- Colorants
    - Coloring matters for mass and surface coloration. (eg: Orange Yellow S. E110)
    - Dyestuffs for coloring only on the surface. (eg: Calcium Carbonate E170)
    - Coloring matters for certain uses only. (eg: Pigment ruby E180)
- Conservatives
    - Conservative agents (eg: Sorbic acid E200)
    - Substances used for other uses, but with secondary preservative effects (eg: potassium nitrate E249)
- Antioxidants
    - Antioxidants (eg: L-ascorbic acid E300)
    - Substance with antioxidant action in addition to other functions (eg: E220 sulfur dioxide)
    - Substances reinforcing the antioxidant action of other substances (eg: Lactic acid E270)
- Emulsifying agents, stabilizers, thickeners and gelling agents (eg: Lecithin E322)
- Anti-caking agents (eg Silica E341)
- Texture agents (e.g., E290 carbon dioxide)
- Flavor agents (eg: Sodium Chloride E420)
- Aromatization agents (eg: Smoke aromas)
- Helpers and various (eg: Pimaricin)

In this case an additive will be used for the production of preserved peppers, both in Appellation of origin and in production of piquillo variety of peppers and in the production of preserved asparagus. That product is described below.

Citric Acid

According to the International Numbering System for food additives, citric acid is numbered as E 330. Following this system, this additive has as technological functions:

- Color retention agent
- Antioxidant
- Acidity regulators

Both in canned peppers and asparagus, citric acid is incorporated with the objective of regulating the acidity of the food. By regulating the acidity of the food it is possible to lower the pH thereof, in this way we facilitate the next food preservation processes, since as the pH decreases, a smaller number of microorganisms will be able to develop, and a smaller number of microorganisms will have to be eliminated or inhibited in thermal processes. A decrease in pH in the food causes a much more aggressive environment for the possible agents that cause deterioration and loss of quality of the food.

In preserved vegetables with a pH lower than 4,6, such as fruit, tomatoes or in this case acidified canned products such as pepper, the heat treatment to be used does not usually exceed 100°C. At this temperature all the spores are not destroyed, the acidity of the product prevents germination, however, the temperature itself is sufficient to destroy pathogenic microorganisms such as Salmonella, Staphylococcus aureus and also yeasts, molds and lactic bacteria.

In canned products of pH equal to or greater than 4,6, as in the case of canned asparagus, the heat treatment goes from being a pasteurization to being a sterilization, whose scale must be very exact and controlled in order to destroy germs capable of producing toxins and inhibiting the presence of Clostridium botulinum spores. The pH of the asparagus is in 4 and 6, while the pH of the peppers is between 4,6 and 4,9. For this reason, acidulants are added to both pepper and canned asparagus.

Salt

Salt is one of the main ingredients in canned vegetables, it is added in the government liquid together with water and other additives. In the water section, the different functions that the government liquid must fulfill are explained. The salt, like the rest of the ingredients, must be added to the appropriate size for the preparation of the different canned products. One of the functions of the addition of salt in the government liquid is to improve the taste of the product for the consumer. In addition to improving taste, salt is also added for its food preservation functions.

1.2. Auxiliary raw material

1.2.1. Packaging

Taking into account the current regulations regarding the vegetable canning industries, the following general conditions apply to the materials involved in the packaging and production of any preserved food.

Any material that has contact with food at any time of its preparation, processing, distribution and consumption, will maintain the proper conditions of conservation, hygiene and cleanliness and will meet the following conditions, in addition to those others that for each case are specified in the Spanish Food Code (SFC). These conditions are the following:

- Be manufactured with authorized raw materials in the Spanish Food Code
- Do not transmit to food and beverages with which toxic chemicals are contacted or that may contaminate them
- Do not give up any substance outside the normal composition of food and beverages, or even if it exceeds the content authorized in them.

- Do not alter the compositional characteristics and the organoleptic characteristics of the food

The materials that are authorized and that are going to be used in the production of canned products indicated in this industry are the following: Electrolytic tin for cans, ordinary glass for jars of different capacities and wood for pallets.

This section describes the packaging that will be used in this industry at the time of packaging of the final products, following the current regulations on packaging and its materials in the vegetable canning industries.

Glass containers

In the case of glass containers that are going to be used, it is boats of this material. The boat is that small container, commonly cylindrical, that serves to keep both liquids and objects, in this case food, according to the Royal Spanish Academy (RSA).

In the case of canned peppers, the production destined to produce piquillo pepper under the Appellation of Origin "Pimiento del Piquillo de Lodosa" is the one that requires cylindrical glass bottles of 314 ml of capacity.

In the case of preserved asparagus production, boats with a capacity of 580 ml will be used.

The formats of the glass containers for the packaging of canned vegetbales are related to the nominal capacity in ml that this container presents. These nominal capacities are standardized and are specified in the Order of June 21, 1983 on characteristics and formats of canned vegetables, juices and derivatives and sterilized prepared (cooked) dishes.

The characteristics of each container that has been selected are:

Table 26: Glass containers dimensions

Format (ml)	top diameter of the bottle (mm)	Bottle Diameter (mm)	Height (mm)
314	63	68	131
580	63	77	172

Tin cans

As in the previous case, the packaging of canned products using glass containers, in the case of tin cans, the format of them is also related to the nominal capacities in ml and are collected in the same order as the cans of glass.

The cans of tin that will be used in the packaging of preserved peppers will be cans with a capacity of 425 ml. In the case of canned asparagus, 720 ml capacity cans will be used. The characteristics of the tinplate containers chosen are the following:

Table 27: Tin cans dimensions

Format (ml)	Diameter (mm)	Height (mm)	Large (mm)	width (mm)
425	83	85		
720		58	155	80

Closure systems

As for the systems of closure of the containers, the Spanish Food Code conditions the materials of its manufacture in the following way:

- Metal lids coated or not with tin, varnish or enamel; of ceramic materials, porcelain, glass, waterproof cardboard or plastic materials, which ensure a perfect fit, with or without rings of cork, rubber, conglomerates and plastic materials or by welding.
- Crown-type plugs coated with plastic film, aluminum, tin or with a cork disc on their contact surface with food and according to the requirements of preservation of the contents of the container.
- Metal capsules for bottles, insofar as they are isolated by a sheet of tin paper one tenth of a millimeter thick or an aluminum foil or other impermeable material and unassatable in cold by 6% acetic acid.
- Cork stoppers, wood, rubber or plastic materials.

The selected covers for the glass cans will be of metal type covered with plastic materials so as to ensure a perfect closure. They will be covers of sterilizable and pasteurizable type, that is to say that they hold temperatures of more than 120oC. The characteristics of these closing systems are the following:

Table 28: Closure systems dimensions of glass containers

Format (ml)	top diameter of the bottle (mm)	Bottle Diameter (mm)	Height (mm)
314	63	68	131
580	63	77	172

1.2.2. Labelling

The information that must appear compulsorily in the labeling of foods according to the "General norm of labeling, presentation and advertising of food products", approved by Royal Decree 1334/1999 of July 31 is the following:

- Designation of sale of the product.
- List of ingredients.
- The amount of certain ingredients or category of ingredients.
- The alcoholic degree in beverages with a volume superior to 1.2 per 100.
- The net quantity, for packaged products
- The minimum duration date or the expiration date
- The special conditions of conservation and use
- The way of use, when its indication is necessary to make an adequate use of the food product.
- Identification of the company: the name, business name or denomination of the manufacturer or the packer or a seller established within the European Union and in any case, his address.
- The lot.
- The place of origin.

As for the A.O, being an extra quality mark that provides the product, it implies a greater number of restrictions that must also be met regarding the labeling of the products under that name. In this case it is about the Appellation of Origin “Pimiento del Piquillo de Lodosa” and the following must be fulfilled in its labelling:

- It is forbidden to use other names, brands, terms, expressions and signs that by phonetic or graphic similarity with the protected may lead to confusion with those that are the subject of the Regulation of the A.O, although in the case that they are preceded by the expressions "type", "style", "taste", "elaborated in", "manipulated in", "fabricated in" or other analogues.
- Before putting them into circulation, the labels must be authorized by the Regulatory Council, for the purposes that are related in the Regulation of the Appellation of Origin The approval of those labels that for any reason can give rise to confusion in the consumer will be denied. The authorization of a previously granted one may also be annulled, when the circumstances of the firm that owns it have changed, after hearing the signature of the interested party.
- The right to use the Appellation of Origin in advertising, advertising, documentation or labels is exclusive of the firms registered in the Council's records.
- In the labels of the containers, the name of the Appellation of Origin will appear in a prominent way, in addition to the data that are generally determined in the current legislation.
- Regardless of the type of packaging in which they are issued, the canned products for consumption will be provided with a numbered label or counter-label, provided by the Regulatory Council, which must be placed before its issuance in accordance with the norms established by the Council. Regulator.

Regarding the production of canned white asparagus, there are also certain labelling rules that must be met according to the specific labelling requirements for preserved white asparagus established by Royal Decree 946/2003, of July 18. These specific requirements are the following:

- The white asparagus packed for marketing in Spain must have on the label with typographic characters that are the same as the name, company name or denomination used in the identification of the company, and in the same field and visual angle, the following legend:
- In the case of products originating in Spain, the expression "product grown in (province, autonomous community)".
- In the case of a product originating in the European Union, an indication with the expression "product originating from (member state in which the product has been grown)".
- In the case of products originating in other countries, the expression "product originating in (country in which the product has been grown)".

In addition, when the product has been packaged in Spain, the package must contain the sanitary registration number corresponding to the industry in which the product was made. This indication will appear stamped if the container is metallic, and printed with indelible ink, before sterilization, if it is made of glass.

1.2.3. Pallets

The pallets used for the storage of finished products in the food industry are usually the European pallet model of measures 1200 x 800 x 145 mm or the American pallet of measures 1200 x 1000 mm. In this industry in principle both types of pallets will be available to adapt to the different dimensions of cardboard boxes chosen.

1.2.4. Cardboard boxes

Regarding the storage of the containers once the production of the different canned products is finished, cardboard boxes of different sizes are used depending on the packaging format that is going to be stored. The following table shows the measurements of the different boxes used for the storage of glass containers.

Table 29: Cardboard boxes dimensions of glass containers

Bottles format (ml)	Large (mm)	Width (mm)	Height (mm)	bottles capacity(bottle numer)
314	427	285	150	24
580	300	240	175	12

Finally, the tin containers that will be used will be stored in cardboard boxes as in the case of glass containers so that at the time of transport they do not suffer any type of damage due to bumps or rubbing. The formats and measurements of the cardboard boxes will depend on the characteristics of the cans. The measurements of the boxes are shown in the table below.

Table 30: Cardboard boxes dimensions of tin cans

Can format (ml)	Large (mm)	width (mm)	Height (mm)	bottles capacity(núm latas)
425	350	350	90	16
720	470	470	120	18

PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

Public University of Navarre

SCHOOL OF AGRICULTURAL ENGINEERING

Agri-food & Rural Environment Engineering

ANNEX 4. FINAL PRODUCT STUDY

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

March 2018

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1. Product study

This section describes the different final products that will be developed and marketed. The final formats of canned peppers and asparagus. These final products are obtained after the transformation suffered by the raw materials in the designed food industry.

1.1. Canned pepper

Canned pepper can be presented in different ways, the whole product, chopped into strips, cubed..etc. It depends on the function and how the consumer wants it. In this case, a part of the company's production of canned peppers will be dedicated to canned products protected under the Appellation of Origin "Pimiento del Piquillo de Lodosa". The specifications of this quality mark only allow canned peppers to be whole peppers and extra or first categories. The extra commercial category refers to products with carefully selected raw materials, these products have to follow a careful selection process that will result in a high-quality product. The variety that is only allowed is piquillo variety peppers.

Lodosa piquillo pepper is a selection made in Lodosa of a sweet pepper that is morphologically characterized by being red, short length, medium diameter, small fruit weight and with 2 or 3 locules. The fruit has a triangular shape with an acute apex and a pendulous shape.

The annual pepper production will be 470 t, with 150 t of Appellation of Origin "Piquillo de Lodosa pepper" and 320 t of piquillo pepper. The peppers Appellation of Origin they will be packed in glass jars while the piquillo peppers will be packed in metal cans. The ingredients in this case are the peppers and the corresponding additive for the acidification of canned products.

1.1.1. Metal can

One of the formats presented by the canned peppers that are going to be elaborated is a metallic can of cylindrical shape. The preserve will be whole piquillo peppers and extra category. Therefore, the format will be a can of Piquillo peppers extra category. The can has a capacity of 425 ml and the preserved one will have a net weight of 400 g and a drained weight of 340 g. It is required to leave a head space of 6%, therefore, a space of about 25,5 ml. The presentation format will be:

- Piquillo peppers extra category 425 ml

1.1.2. Glass container

In the case of glass containers, a certain head space of 18,84 ml is also required, which in this case represents 6%. It will be produced canned peppers Appellation of Origin with the following format:

- “Pimientos del Piquillo de Lodosa” extra category 314 ml, with a net weight of 290 g and a drained weight of 260 g.

1.2. Canned asparagus

In the first place, 300 tons of preserved asparagus will be produced, of which 200 tons will be white asparagus from Navarra, and the rest, 100 tons will be white asparagus from Navarra covered by the Specific Appellation "Espárrago de Navarra". As previously mentioned, so as to acquire this quality mark in the products, specific requirements must be fulfilled at the time of their elaboration, regulated by the Regulatory Council. Asparagus are classified into three categories that are described below.

1.2.1. Extra category

The shoots belonging to this category must be of superior quality, very well formed and practically straight. Taking into account the normal characteristics of the group to which they belong, their points should be very compact.

Only a few very slight indications of soya spots caused by non-pathogenic agents in shoots that can be eliminated by the consumer through normal peeling will be allowed. Regarding white asparagus, the tips and shoots should be white, only allowing a slightly pink hue in the shoots.

1.2.2. Category I

The turions that belong to this category must be of good quality and be well trained. They may be slightly curved. Taking into account the normal characteristics of the group to which they belong, their tips should be compact.

Slight indications of soybean stains caused by non-pathogenic agents that can be removed by the consumer through normal peeling are allowed. Regarding white asparagus, may present a slightly pink hue in the plants and in the turions. In the group of white asparagus, fibrous shoots are not allowed. With regard to other groups, a slight fibrosity is admissible in the lower part, provided that such fibrosiness disappears through normal peeling by the consumer.

1.2.3. Category II

The turions pertaining to this category are those that can not be classified in higher categories, but they meet the minimum requirements with reference to the asparagus that are the following:

- Be whole
- Be healthy, free of rot or deterioration that makes them unfit for consumption
- Be clean and practically free of any visible foreign matter
- Being practically free of pests that affect the general appearance of the product
- Be practically free from damage caused by pests
- Be free of abnormal external moisture, except for the condensation resulting from its removal from a cold room
- Be exempt from any strange smell and / or taste
- have a fresh look and smell
- Be virtually free of bruises
- Be exempt from damage caused by improper washing or soaking

Compared with category I, the shoots may not be as well formed and more curved and, taking into account the normal characteristics of the group to which they belong, their tips are slightly open. In this category, soybean stains caused by non-pathogenic agents that can be eliminated by the consumer through normal peeling are allowed. The tips of the white asparagus may have a color that includes a green hue. Some fibrosity is allowed in the shoots of the asparagus belonging to this category.

Once the classifications of the asparagus are described, they are separated based on the sizes they present. Regarding the classification by sizes, it is necessary to take into account the length of the shoots and their diameters.

As for the length of the shoots, they must be greater than 17 cm for the asparagus considered as long. Asparagus with a shoot length between 12 and 17 cm will be considered short. As for the asparagus belonging to category II that are arranged neatly but not in bundles, the shoots should measure:

- White and violet asparagus: From 12 to 22 cm
- Violet and green asparagus: From 12 to 27 cm

The maximum length for white asparagus is 22 cm, while for violet / green and green asparagus it is 27 cm.

The diameters to be taken into account are those of asparagus that are considered large or very large, with diameters between 13 and 25.4 mm. The former would have a diameter range between

13 and 18 mm, while those that are considered very large have a range of between 18 and 25.4 mm.

In this industry they will be marketed in different whole white asparagus and long, and a small part of the production of short asparagus will be commercialized in case there is not enough quantity of long asparagus.

As for the category, they will be Extra category, this means that the asparagus to be transformed have a minimum length of 12 cm and a maximum of 22. They have white, cream or yellow stems, with no more than 20% of stems whose tip has a green, light green or yellowish green color. In addition, the turion diameters will be within the margins described. In addition, in the different preservation formats that are elaborated, it must be fulfilled that the government liquid represents 41% of the total maximum. Next, the formats that are going to be elaborated of canned asparagus are described.

The production is divided into asparagus Specific Appellation "Espárrago de Navarra" and white asparagus of Navarra not covered under the Specific Appellation. The asparagus Specific Appellation are packed in glass containers while the white asparagus from Navarra are packed in metal cans.

1.2.4. Metal can

The canned products presented in 1 kg format will be packed in tin cans of 720 ml capacity. It is required to leave a headspace of 6%, therefore, a space of about 43.2 ml. A net product weight of 680 g is proposed, of which 40% represents the government liquid. In this way the products will have a net weight of 680 g and a drained weight of 408 g. The format of the white asparagus will be:

- White asparagus can 6/8, extra category,1 kg (680 g), very thick.

The drained weight of the asparagus as mentioned will be 408 g, therefore, the weight of the government liquid will be 272 g, of which 0,7 g will be salt. The citric acid is added by some tablets to the total of the mixture and does not represent a significant weight. The rest is from water.

1.2.5. Glass container

Regarding the production of canned asparagus, apart or using tin cans, there will be used also glass containers. This type of packaging is more attractive for a part of the consumers since one of its characteristics that make it different is that you can see in what state the product that is being purchased is currently.

The chosen glass bottle is a pot of capacity 580 ml. As in the previous cases, it is necessary to leave a 6% head space so that the closure is adequate and no damage occurs due to pressures in the sterilization. In this case about 35 ml of free space will be left. A net product weight of 540 g, a drained weight of 325 g, is proposed. In this way, the percentage of government liquid will be 60%. Next, the format to be elaborated of this type of canned asparagus is presented:

- "Espárrago de Navarra" bottle 6/8, extra category, 1 kg (540 g), very thick.

PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

Public University of Navarre

SCHOOL OF AGRICULTURAL ENGINEERING

Agri-food & Rural Environment Engineering

ANNEX 5. INDUSTRIAL ACTIVITY PLANNING

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

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1. Industrial activity planning

In this section we will describe the planning for the production of the canned vegetables. In this industry, initially, the industrial activity will consist of the production of two different canned vegetables. The products will be, canned piquillo pepper and canned asparagus of Navarra. The annual production of the plant will be 770 t. This production is divided into the two final products as follows:

- Canned piquillo peppers:
  - Appellation of Origin "Pimiento del Piquillo de Lodosa", 150 t.
  - Canned piquillo peppers, 320 t.
- Canned asparagus
  - Specific Appellation "Espárrago de Navarra", 100 t.
  - Canned asparagus, 200 t.

In this way, the production of canned peppers represents 61.03% of the total, the production of asparagus represents 38.97%. Thus, the pepper is the priority product in this canning company.

The food industry is a sector that mostly works according to seasons since each product has its production, planting and harvesting season. In this way, these two canned products have been chosen since they have very different collection periods during the year and thus have the plant in operation at different times of the year. This planning provides time between both productions dedicated to the maintenance of the machinery.

The calendar has been organized in the following way, the working days of each month of production have been taken into account, and taking into account the result has been divided each month into three boxes, each representing one week of work. The weeks correspond to 7 working days since all the calculation is done starting only these days, no holidays or end of weeks are counted. This method has been decided with the objective of having available days if an improvisation arises, taking some of these non-working days. In the two seasons, two working days a day are required, one in the morning of 8 hours and another in the afternoon of 6 hours with change in personnel.

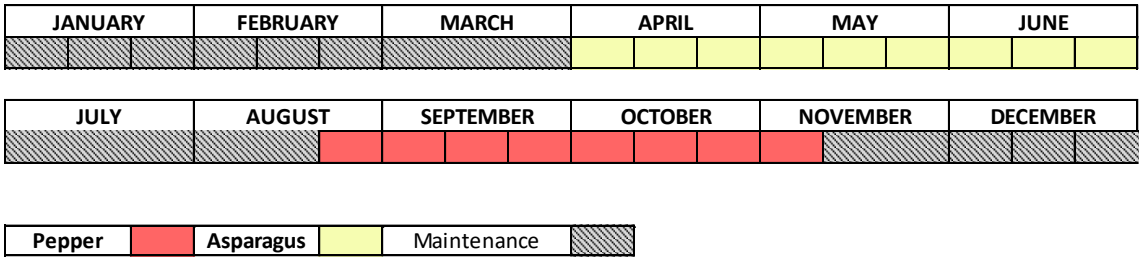

Figure 25: Industrial activity planning calendar

As it can be observed in the calendar, the time devoted to maintenance is very high, this is a design of the initial planning, the day you decide to expand the company and produce another product, the calendar would be modified.

From this, each product has an annual production that must be obtained, the average daily amount of each product has been calculated. Below, each specific case is explained.

2. Canned pepper

2.1. Introduction

The annual production of pepper in this industry will be 470 t. This production is divided in two, since part of the production will be covered under the Appellation of Origin "Pimiento del Piquillo de Lodosa", while the rest of the production will be piquillo pepper and will not be protected by the quality mark.

The two differentiated productions have different presentations since the production covered under the Appellation of Origin it will be presented in a glass jar while the rest of the piquillo pepper production will be presented in a metallic can. For this reason, the production will be of a sequential nature divided into two different phases. First, the phase of piquillo pepper that is not covered under the Appellation of Origin and in the second shift of the working day the phase of the piquillo pepper covered by the appellation of origin.

2.2. Organization system

The organization of the two differentiated phases has been carried out in the following way: The process of transformation of the peppers has three major stages, being the first and third continuous and the second discontinuous. The planning has focused on the discontinuous stage, the thermal treatment in autoclaves, and according to the capacity of them, the shifts of each phase have been organized.

2.2.1. Canned piquillo pepper

Being the initial production of 300 t per year of piquillo pepper and estimating 50 working days a daily amount of 6000 kg is obtained. Taking into account the dimensions of the cages and the capacity of them, the quantity is adjusted to 6400 kg per day, thus the equipment works in full practically. Following this production, two shifts are required in the autoclave to treat the 6400 kg in one day. In this way, the annual production of piquillo pepper increases to 320 t per year.

The times of the three stages have been calculated according to the production assigned to each shift. The two turns of piquillo pepper can production are identical in terms of time and quantities to produce, so the data mentioned below are referred to a shift.

Table 31: Duration of the first stage

First stage				
Steps	capacity		Time	
Selection	1500	kg/h	2,13	h
Roast	1000	kg/h	3,2	h
Disheartened	1200	kg/h	2,67	h
Pips removal	1200	kg/h	2,67	h
filling	1200	kg/h	2,67	h
Closure	4800	kg/h	0,67	h

The first stage of the process, being a continuous one, chooses the time of the machine that takes the longest time to carry out its task. In this case the roast, 3.2 hours. The second stage is discontinuous and is the thermal treatment that lasts in this case 66 minutes in total. The third stage consists of palletizing the cans to store them. The equipment in question has the capacity to pallet 3840 kg of piquillo pepper cans in 1 hour, so the time dedicated to this third stage is 50 minutes. Thus, summarizing in the same table, the organization of piquillo pepper production is presented.

Time (min)														
0	A		110	A		215	A	B	320		B	430		B
5	A		115	A		220	A	B	325		B	435		B
10	A		120	A		225	A	B	330		B	440		B
15	A		125	A		230	A	B	335		B	445		B
20	A		130	A		235	A	B	340		B	450		B
25	A		135	A		240	A	B	345		B	455		B
30	A		140	A		245	A	B	350		B	460		B
35	A		145	A		250	A	B	355		B	465		B
40	A		150	A		255	A	B	360		B	470		B
45	A		155	A		260	A	B	365		B	475		B
50	A		160	A		265	A	B	370		B	480		B
55	A		165	A		270	A	B	375		B	485		B
60	A		170	A		275	A	B	380		B	490		B
65	A		175	A		280	A	B	385		B	495		B
70	A		180	A		285	A	B	390		B	500		B
75	A		185	A		290	A	B	395		B	505		B
80	A		190	A		295	A	B	400		B	510		B
85	A		195	A		300	A	B	405		B	515		B
90	A		200	A	B	305	A	B	410		B	520		
95	A		205	A	B	310	A	B	415		B	525		
100	A		210	A	B	315	A	B	420		B	530		
105	A		215	A	B	320	A	B	425		B	535		

Stage 1		Stage 2		Stage 3	

Figure 26: Organization of piquillo pepper phase

In this table the turns 1 and 2 of corresponding piquillo pepper production are represented with the letters A and B. The day begins with the first stage of turn A, once it finishes and the first autoclave is filled, the second stage of the same shift begins, at the same time the first stage of the second shift has also begun. In this way, the 66 minutes that the heat treatment of the first shift lasts, are also used to elaborate the production of the second shift and thus gain time.

Following this scheme at 7 and 45 minutes to start, this is all the processed and processed product and would subtract the palletizing of the second shift. Part of the personnel belonging to the afternoon shift will supervise the last palletizing of the morning and then 30 minutes will be dedicated to the cleaning of the plant.

2.2.2. Appellation of Origin “Pimiento de Piquillo de Lodosa”

The production of piquillo peppers under the designation of origin, "Pimiento del Piquillo de Lodosa" is 150 tons per year. The daily amount to produce is 3000 kg. In this case, only one shift is required in the autoclave. The times of the three stages have been calculated as in the previous case. These times are presented below.

Table 32: Duration of the first stage

First stage				
Steps	Capacity		Time	
Selection	1500	kg/h	2,01	h
Roast	1000	kg/h	3,016	h
Disheartened	1200	kg/h	2,51	h
Pips removal	1200	kg/h	2,51	h
Filling	1200	kg/h	2,51	h
Closure	4800	kg/h	0,63	h

As in the case of piquillo peppers, the time of the machine that later on to carry out its task is chosen, in this case the roast again taking 3,016 hours. The time of the second stage is the same as in the previous case, 66 minutes. Finally, the third stage lasts 44 minutes, since the capacity of the palletizer is 4170 kg / h. The capacity of the palletizer varies because it is expressed in kg of product palletized per hour, but in both cases it is 600 boxes per hour, what varies is the number of containers that fit in each box. Next, a table with the scheme to follow in the phase of the piquillo pepper D.O. Piquillo pepper from Lodosa.

Time (min)

0	C	110	C	220	C
5	C	115	C	225	C
10	C	120	C	230	C
15	C	125	C	235	C
20	C	130	C	240	C
25	C	135	C	245	C
30	C	140	C	250	C
35	C	145	C	255	C
40	C	150	C	260	C
45	C	155	C	265	C
50	C	160	C	270	C
55	C	165	C	275	C
60	C	170	C	280	C
65	C	175	C	285	C
70	C	180	C	290	C
75	C	185	C	295	C
80	C	190	C	300	C
85	C	195	C	305	
90	C	200	C	310	
95	C	205	C	315	
100	C	210	C	320	
105	C	215	C	325	

Stage 1		Stage 2		Stage 3	

Figure 27: Organization of Appellation of Origin Pimiento del piquillo de Lodosa

This figure represents the only shift of the afternoon with the letter C. As it can be seen, the working day of the afternoon lasts 5 hours, leaving enough time afterwards to carry out the cleaning of the plant.

3. Canned asparagus

3.1. Introduction

The annual production of asparagus in this industry will be 300 t. This production is divided into two, since part of it will be covered under the Specific Appellation "Espárrago de Navarra", while the rest of the production will be white asparagus from Navarra and will not be protected by the quality mark.

The two productions have different formats of final product since the production of asparagus Specific Appellation will be presented in a glass bottle while the rest of the white asparagus will be presented in a metal can. As in the previous case, production will be of a sequential nature since it is divided into two distinct phases. First, the phase of the white asparagus of Navarre that is not covered under the Specific Appellation and on then the phase of asparagus Specific Appellation will take place.

3.2. Organization system

The organization has been designed as in the case of the pepper, focusing on the three major stages that form the process of transformation of the asparagus. The first and third stages are continuous processes and the second one is discontinuous. As in the previous case, the organization has focused on the discontinuous stage and everything has been calculated according to the capacity of the autoclaves.

3.2.1. White asparagus from Navarre

The production of white asparagus from Navarra is 200 t per year, estimating 64 working days, a daily amount to be produced of 3125 kg is obtained. As in the case of pepper, the time that each of the three stages lasts has been calculated. The following table shows the time of the first stage.

Table 33: Duration of the first stage

First stage				
Steps	Capacity		Time	
Selection	1500	kg/h	2,01	h
Roast	1000	kg/h	3,016	h
Disheartened	1200	kg/h	2,51	h
Pips removal	1200	kg/h	2,51	h
Filling	1200	kg/h	2,51	h
Closure	4800	kg/h	0,63	h

Being a stage that works continuously, the highest time is chosen, in this case 3.6 hours that the peeling stage takes to be completed. The second stage corresponds to the thermal treatment of the asparagus, which has been assigned a time of 90 minutes. Finally, the third stage also corresponds in the case of peppers to the palletizing of the product and lasts 26 minutes. The following table summarizes the production of white asparagus from Navarra in the industry.

Time (min)							
0	A	105	A	210	A	315	A
5	A	110	A	215	A	320	A
10	A	115	A	220	A	325	A
15	A	120	A	225	A	330	A
20	A	125	A	230	A	335	A
25	A	130	A	235	A	340	A
30	A	135	A	240	A	345	
35	A	140	A	245	A	350	
40	A	145	A	250	A	355	
45	A	150	A	255	A	360	
50	A	155	A	260	A	365	
55	A	160	A	265	A	370	
60	A	165	A	270	A	375	
65	A	170	A	275	A	380	
70	A	175	A	280	A	385	
75	A	180	A	285	A	390	
80	A	185	A	290	A	395	
85	A	190	A	295	A	400	
90	A	195	A	300	A	405	
95	A	200	A	305	A	410	
100	A	205	A	310	A	415	

Stage 1		Stage 2		Stage 3	

Figure 28: Organization of the white asparagus from Navarre phase

In this table, the letter A shows the only autoclave shift necessary for the daily production of 3125 kg. As can be seen in the diagram, the working day in the morning lasts 5 hours and 40 minutes, thus leaving enough time for subsequent cleaning.

3.2.2. Specific Appellation “Espárrago de Navarra”

The production of asparagus covered under the Specific Appellation it is 100 t per year, which means a total of 1570 kg per day, estimating 64 days of work in the season. As in the previous cases, the time of the three stages has been calculated and the table is presented with the time of the first.

Table 34: Duration of the first stage

First Stage				
Steps	Capacity		time	
Washing	1800	kg/h	1,73	h
Selection				h
Peeling	868	kg/h	3,6	h
Blanching	1000	kg/h	3	h
Filling	980	kg/h	3,2	h
Coberture liquid	5700	kg/h	0,54	h
Closure	6480	kg/h	0,4	h

Being continuous processes, the highest time is chosen, that is, 1,8 hours that the peeling task takes to be completed. The second stage corresponds to the thermal treatment and lasts 90 minutes in this case. Finally, the third stage that consists of palletizing the product requires 25 minutes. Summing up the organization in a table, the following figure is presented.

Time (min)					
0	B	105	B	210	B
5	B	110	B	215	B
10	B	115	B	220	B
15	B	120	B	225	B
20	B	125	B	230	B
25	B	130	B	235	B
30	B	135	B	240	
35	B	140	B	245	
40	B	145	B	250	
45	B	150	B	255	
50	B	155	B	260	
55	B	160	B	265	
60	B	165	B	270	
65	B	170	B	275	
70	B	175	B	280	
75	B	180	B	285	
80	B	185	B	290	
85	B	190	B	295	
90	B	195	B	300	
95	B	200	B	305	
100	B	205	B	310	

Stage 1		Stage 2		Stage 3	

Figure 29: Specific Appellation Espárrago de Navarra phase

In this table, the only turn related to the production of asparagus Specific Appellation is represented by the letter B. As it can be observed, the production day lasts 3 hours and 56 minutes.

In this way, the necessary annual production is obtained and sufficient time is available to carry out the subsequent cleaning of the industry.

4. Workers

In this point the needs of personnel in plant that requires the industry to be able to produce the annual quantities of pepper and asparagus are collected. For the industry in general, there is a manager, four laboratory technicians, two sales people, one employee responsible for the reception, three administrative assistants, one production manager and ten workers responsible for maintenance. These positions are fixed as to the number of them, however, the workers number varies depending on the season that is.

4.1. Pepper production season

Within the elaboration process of canned peppers, there are some stages that must be done manually by the workers and those are the following ones:

- Disheartened
- Peeling and pips removal
- Filling

In order to accomplish with the annual production of pepper of 470 t, a circular transporting band will be first placed, in which the disheartening will be carried out. On this band, 20 employees will be required to deposit the product once the heart of the product has been removed. same in the inner tape of the equipment, so that the two stages are communicated.

The next stage is the peeling and pips removal of the peppers, in which another circular band is used as in the previous stage of disheartened, which will require 20 employees again.

The next manual stage of the process is the packaging of the peppers, this third manual stage is directly communicated with the previous stage and 20 employees are required.

Therefore, taking into account the stages of the process that will be carried out manually, in the case of canned peppers, 60 workers will be required for the personnel in the industry.

4.2. Asparagus production season

In the case of canned asparagus, the stage of the process that will be carried out manually is the packaging that is made up of conveyor belts in which 8 people work in each one, so in this stage 16 people will be needed.

However, in previous stages that are carried out by specific machinery, personnel are needed in them.

- Washing and selection: 7 Workers
- Automatized peeling: 2 Workers
- Blanching: 4 Workers
- Closure (supervising): 1 Worker

Therefore, so as to accomplish the annual production of asparagus of 300 tons it is required 30 workers to carry out the necessary activities and supervising.

PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

Public University of Navarre

SCHOOL OF AGRICULTURAL ENGINEERING

Agri-food & Rural Environment Engineering

ANNEX 6. PRODUCTION PROCESS TECHNOLOGY

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

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1. Production process technology

In this section of the project is going to describe the alternatives that exist about the production process technology of the two production lines. The flux diagrams are presented and each of the stages.

2. Flux diagrams of the process technology

2.1. Canned peppers

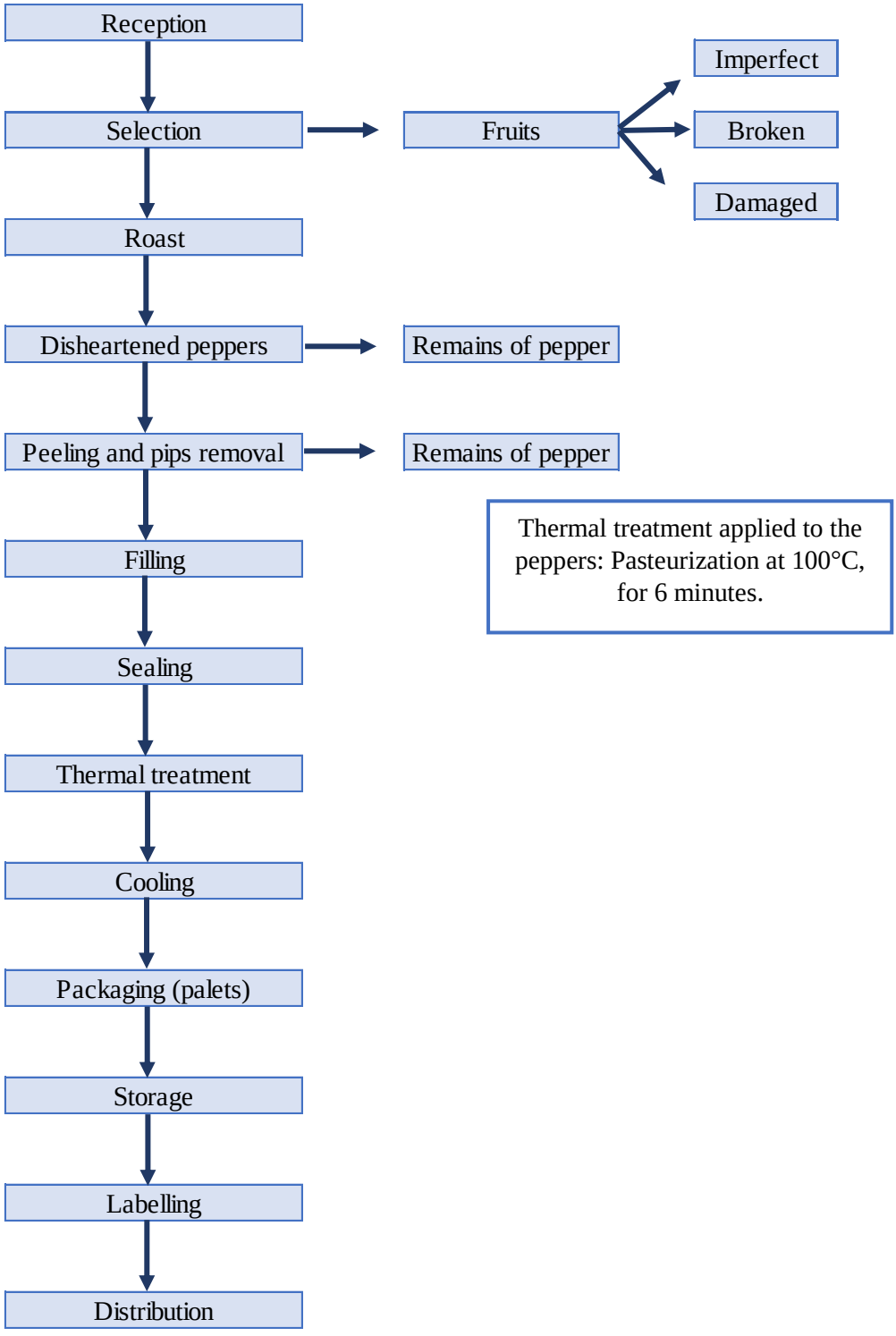

Figure 30: Process technology flux diagram, canned peppers

2.2. Canned asparagus

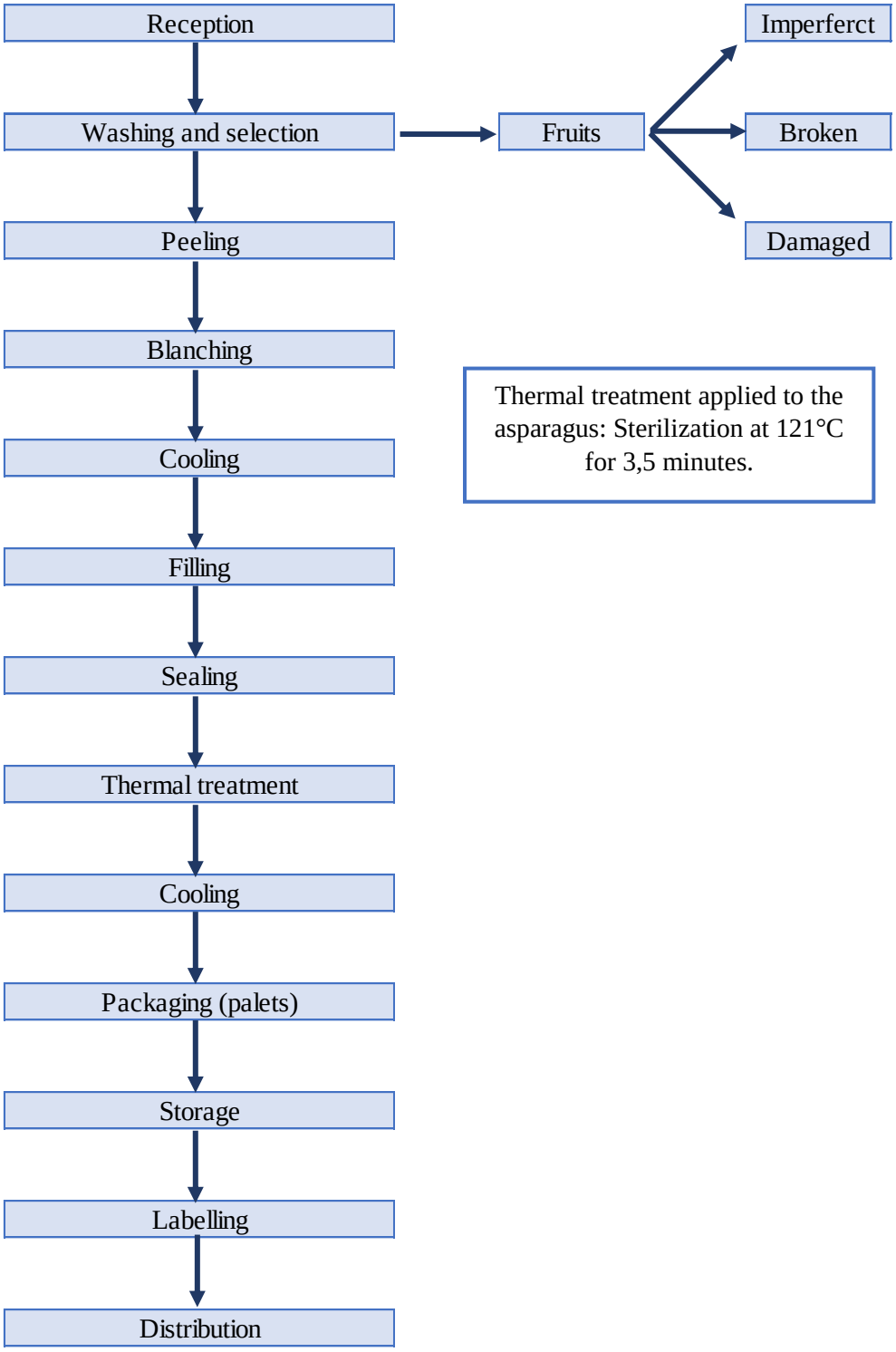

Figure 31: Process technology flux diagram, canned asparagus

3. Alternatives of the production process technology: Piquillo peppers

3.1. Elaboration method

The first alternative that appears about the preserved pepper production is the following one. This industry is going to produce preserved peppers protected by the Origin Denomination "Pimiento de Piquillo de lodosa" and preserved peppers not protected by this denomination. The O.D. has its own specification sheet that must be fulfilled so as to obtain the protection in the products, so, the first problem that appears is that the industry is following this sheet in all the products or only in the ones that are going to be with that extra quality.

3.1.1. Chosen alternative

In this case it is decided to apply the same elaboration method in all the products that are going to be produced in this industry. This is due to the fact that this specification sheet does not make any restriction that cost a significant amount of money and taking about organization is much more easier. In the following points, the technology process periods are going to be described and the alternative that are chosen.

3.2. Selection

The selection of the products is in the moment that are received, that is why the damaged products are not going to be processed. In addition, the specification sheet of the O.D. demands that the selection must be an exhaustive process, this demanding does not make the option of different alternatives, so, the selection is going to be by an automatic devise capable of classify the not damaged products.

3.3. Washing

The washing process is considered necessary because of the major part of the food products harvested from the land may content some pollution substances that can not be eaten, and they must be eliminated in order to continue with the next actions in the transformation process. Following this way, the quality of the product is increased. The definition of the process is a unitary operation that leaves the product in an optimal way for the next elaboration. The washing can be classified as humid or dry washing.

3.3.1. Dry washing

The dry washing is used in food products with major consistency, lower size and lower water content for example cereals, nuts or hazelnuts. Once the cleaning is finished, the food surface is dry getting better the product for its conservation. The facilities of the dry washing method are generally generating lower amounts of wastes that the humid washing method, due to the fact that dealing with the dry effluent is cheaper. Nevertheless, in occasions it is necessary to invest more money in the washing of the products avoiding this way the dust generation that can end with dangerous explosions. The equipment necessary for the dry washing methods are classify in air separators, magnetic separator and purge separators.

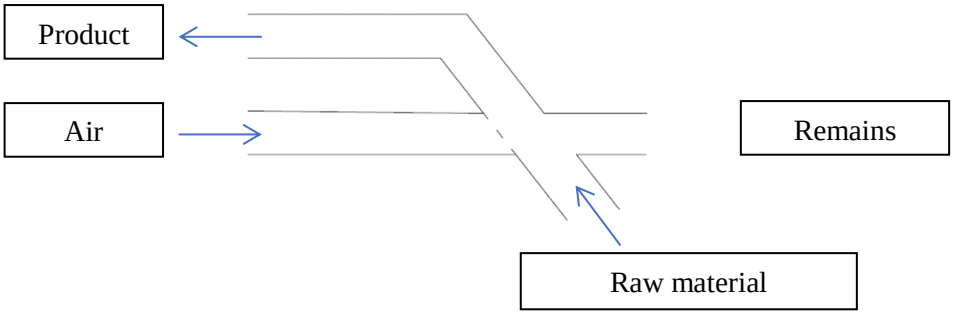

Figure 32: Dry washing scheme

In the previous image it is represented a scheme about the separation of the remains by aspiration as dry washing method. This kind of separators, also known as classifiers, function based on an air flow that eliminates the pollutant substances because of the difference in density. This type of classifiers is used a lot in order to separate the grain of the vegetables or the heaviest pollutants as stones.

3.3.2. Humid washing

The humid method is a process that produces less food damage than the previous method, besides not producing dust. It is normally used for the soft fruits and vegetables cleaning, being one of its functions, the elimination of pesticides. By using the washing method, it is required to use specific washing times in order not to provoke chemical or microbiological alteration. This kind of method normally produces extra expenses in the industries due to the acquisition of clean water and dealing with the big volumes of effluents produced. One possible option is the installation of one effluent treatment plant in the industry. The humid washing methods are classified by shower devices, brushing devices, drum washers and floating deposits.

3.3.3. Chosen alternative

In this case, it is decided to choose a humid washing method, that is why it is the process that less food damage provokes and the more adequate to the vegetables. Furthermore, it is decided to use this kind of method due to the fact, that it can eliminate pesticides remains that can be present in the product. In addition, it does not make any sense to choose a dry washing method because the material that must be eliminated is land between the roots and the products to be cleaned are soft products that can be damaged by using dry methods.

3.4. Roast

The process of roasting the peppert has the aim to burn the skin and make it splits from the pulp. The specification sheet of the D.O. demands that the roast must be done by using a direct flame equipment over the product, so there are no more alternatives in this period of the process.

3.5. Peeling, pips removal and pepper heart removal

The peeling, is one of the necessary processes and one of the most important in the transformation process of fruits and vegetables. It consists in the elimination of the not eaten material of each particular food product. It is necessary that the food product must end cleaned and without suffering any type of damage. There exist different types of peeling as for instance: vapor peeling, abrasion peeling, caustic peeing or peeling by using knifes. Nevertheless, the specification sheet of the D.O. demands that the peeling must be manual, so, there are no more alternatives to choose.

In the flux diagram, the peeling, pips and pepper heart removal are two different period, but in reality, they take place the same way, using manual methods.

3.6. Packaging (can and glass packaging)

The packaging is one of the most important periods of the production cycle of any food product. The packaging can be defined as a way to obtain a secure supply of products in good conditions to the final consumer and with a minimal cost. The functions of the packaging are:

- Protection: Against risks of mechanical or environmental type that might appear during the distribution period.
- Contention: Maintain the package contain in a secure way to the consumer
- Communication: To communicate and identify the content of the package to the consumers
- Functionality: In order to let the machinery work faster and better
- Commodity: During the production, distribution, storage, discharge, and an easily handling for the final consumer.

In the packaging state, take place two different operations that are the fill in and the sealing of cans.

3.6.1. Filling

The success of the conservation methods depends on an adequate filling, as it avoids the microbiological alteration of the treated products. The filling can be manual or automatized, it depends on the characteristics of each product. In this case, peppers present certain difficulties in order to use an automatized method, so they are not taken into account.

3.6.2. Sealing of the packages

The sealing of the cans has a lot of importance as it is necessary to be formed a vacuum In its interior in order not to provoke problems due to the over-pressures during the thermal treatments. The equipment in charge of the sealing also will create the necessary vacuum.

When it is applied a huge amount of heat in a package as the one that is going to be applied during the thermal treatment, it is created an internal pressure due to the product expansion, the increasing of the water vapor pressure and the air expansion that is in the head space. The containers are designed to counteract this internal pressure with expansion rings that they have. Nevertheless, a can that is completely full it would be exposed to an excessive effort. That is why it is necessary to leave some head space where not only the gasses pressure is adapted but the heat transmission is facilitated. In containers that are going to be expose to temperatures between 115-121°C the head space must not be lower than the 6% of the container volume.

3.7. Heat treatment

The thermal treatment is really important in the production cycle. It exists two different thermal treatments that vary depending on the conditions of time and temperature of application and on the thermal agent used. The treatments that are applied in the food industries are the pasteurization and the sterilization.

It is possible to inhibit and to end with the microbial threats, that are damaging the products and diminishing their quality by the application of heat. By the heat application to the elaboration process, it is controlled by an easy way the process conditions that must be followed, stable food products are obtained and the availability of some nutrients is increased.

Nevertheless, this kind of processes also modifies the sensory components of the food as the aroma or the texture. For this reason, a treatment has to be designed for each kind of product and the use that it will have, varying in each case the temperature and the of process.

3.7.1. Pasteurization

The pasteurization is a thermal treatment that it is applied as a conservation method for food, it is considered light process because it only reaches temperatures of 100°C as highest. The conservation is due to the combination of the treatment with other factors as for instance the low pH or high concentration of sugar or salt.

This treatment is considered light as it has been said, so, the changes in the organoleptic properties that the product can suffer after being expose to the pasteurization are not important.

3.7.2. Sterilization

The sterilization is the thermal treatment capable of destroy all the microorganisms susceptible of multiply themselves in normal conditions of storage. The resistance of the spores of certain bacteria is really high against heat, being necessary for their destruction temperatures of 121°C during long times. There are some changes that can appear during this processes that can provoke total loss of organoleptic properties of the product.

The commercial sterilization is referred to the thermal treatment of preserved food that can have viable spores of thermophiles microorganisms, not being totally sterile. Due to the Spanish food code, the industrial sterilization is the process that ends or inactivate during a determined period all the forms of life of microorganisms capable of produce alterations in food, in normal condition of storage. That is why, the acid preserved vegetables, despite have been pasteurized, they are considered commercially sterile because the spores cannot germinate under the pH.

In order to choose one treatment or other one it is necessary to know the factors that affect the sterilization of a product, based on that the conditions for that treatment will be defined. The factors that affect the sterilization of the product are the next ones:

3.7.3. Factors affecting thermal treatment

Acidity

The acidity is an important factor, the lower the pH is the worst are the conditions for the microbial development. In order to be able to divide in different formats of thermal treatment depending on the acidity, it is necessary to stablish a limit point that divide the food. This point is pH 4,6.

The preserved products with a pH lower than 4,6 are considered acid products and the thermal treatment does not exceed the 100°C. This temperature is capable of eliminate a big part of microorganisms, but it does not remove the spores, however, the environment of high pH inhibit its germination.

The preserved products with a ppH equal or higher than 4,6, require a more severe treatment because the development conditions that the microorganisms have are much more favorable. In this cases, the sterilization terms have to be really controlled and calibrations must be done in the equipment in order not to commit any mistake because the quality of the final product is in risk. The aim of this treatments is the total destruction of the microorganisms and the viable spores capable of making alterations in the food. Following that way, the presence of *Costridium botulinum* is completely inhibited, microorganism that is the reference to take into account.

Heat penetration in the container

The transmission of heat through the food is produced by conduction and by convection. In solid foods, the transmission takes place by conduction, a method that is slower than convection and that has as a consequence an overheating of a certain part of the product that will be in contact with the edge of the container. This means that for the specified temperature to reach the center of the container, the temperature at which the part of the product that is stuck to the container has to be subjected will be higher. This can cause some degradation in the package.

As for liquid foods, the transmission of heat occurs by convection, appearing currents from within the liquid mass. This method is faster reaching the temperature determined before and without causing overheating.

To measure the penetration of heat in the containers temperature probes of type PT 100 or thermopares are used. The tip of the probe is placed, which is the part that measures the penetration of heat in the critical area of the container, that is, at the later heating point. In the case of solid foods, this point of the container is located right in the geometric center of the container, while in liquid foods it is located on the axial axis of the container, at about a third of its height. The placement points of the probes vary since the method of heat transmission also varies, by conduction or convection.

The heat penetration during thermal treatments depends on the layers that must be traversed, the factors that influence the heat penetration in the food in question during the sterilization process are the following:

- Nature of the container

- Size and shape of the container

- Product consistency

- Concentration of government liquids and their characteristics

- Agitation of the container

- Temperature and time of treatment

- Thermo-resistance and kinetics of destruction of microorganisms

3.7.4. Chosen alternative

In order to choose the heat treatment that is going to be used, it is necessary to define three concepts first.

D factor

The D value is known as the Decimal Reduction Time (DRT), being this the time required to apply a constant value of temperature to reduce the microbial population by 90%.

Z factor

If the values of D at different temperatures are plotted against a decimal destruction time, a graph is obtained whose slope is called the value of z. Therefore, Z, is known as the number of degrees Celsius that the temperature must be increased to reduce the D value to 10%.

F factor

Finally, to apply it to practice, to a real heat penetration curve, parameter F was set. The parameter F is the equivalent in minutes at some reference temperature, of all the lethal heat in a process with respect to the destruction of an organism characterized by some given Z value. Therefore, the ultimate goal of thermal treatments will be to achieve a certain F for each specific product.

Each product is assigned a value of F that is directly related to the pathogenic microorganism that can damage that product. In the case of preserved peppers, since it is an acidic product since its pH <4.6, it has been awarded the following F: F 16 100 = 6.0 minutes. In this way, maintaining the temperature of 100 °C at the critical point of the container for 6 minutes, the probability of survival of the pathogenic microorganisms is negligible. Thus, the temperature will not exceed 100 ° C so it is a pasteurization.

3.8. Cooling

The cooling stage takes place in the same equipment that applies the heat treatment and consists of reducing the temperature after being subjected to high temperatures. As this process takes place in the same pasteurization equipment in this case, there are no alternatives to choose from.

3.9. Storage

The storage of finished products or raw materials can be carried out at room temperature or under controlled conditions of temperature, humidity or composition of the atmosphere. The quantities of ingredients tend to be reduced in the factories due to the following:

- The money is invested in the raw materials and materials necessary for the production of the products, if the quantity stored in stock is very high the liquidity of the company may be affected.

- During storage, chemical or physical alterations can occur both in the food and in the packaging, leading to a loss of quality.
- The storage facilities have a high economic cost.

Although the company's warehouse should not be very high, it is also necessary to have a certain level of stock in terms of ingredients since the food market is generally a seasonal market. One of the important aspects of the warehouse that must be taken into account and that sometimes is not given as much importance is the physical conditions of the storage area. Hygiene conditions similar to those that exist in the rest of the stages of the process must be maintained since, if there cannot be product contamination and economic losses. These measures that are necessary to carry a correct storage have more importance in the finished products since the money invested in the whole production process is at stake. The main causes of contamination in the storage stage are:

- Contamination by rodents, birds, insects and microorganisms.
- Pollution by dust or foreign bodies
- Respiratory activity of fresh foods or enzymatic activity that cause stale or brown products to appear
- Losses due to leaks, container breakage
- Incorrect storage conditions, such as exposure to light in photosensitive foods.

3.10. Distribution

The distribution chain can be defined as the link between the procurement, the production of a food and its purchase by the consumer. An efficient distribution chain is based on:

- System capable of providing the customer with the required product in time, place and the conditions demanded.
- Ability to reduce the cost to a minimum.
- Maintain product quality throughout the distribution stage.

Nowadays, as consumer demand evolves, the market and the parts that comprise it have evolved. Consumers are currently requesting a greater number of products, with greater availability and variety. For this reason, companies have also had to evolve in terms of distribution. A few years ago, food companies commissioned each product to a small distributor that was only responsible for that particular type of food, while now each company is responsible for the distribution and all the production they do. To carry out this change, they have been forced to study new ways of coordinating transports between fresh, frozen and dried foods, as well as changing the method and frequency of orders and more improvements they have carried out.

4. Alternatives of the process technology: White asparagus

4.1. Elaboration method

In this case, as in the case of preserved piquillo peppers, it is decided to produce in all the products the specifications of the Specific Appellation "Espárrago de Navarra". In this way, the organization is greatly simplified, in addition, the restrictions of the specifications do not involve a large economic expense that may be a problem.

4.2. Selection

The D.O. is a quality brand that assures the consumer that the product they are purchasing has a quality superior to the rest of the commercial products. For this reason, the initial selection before the transformation is important and must be carried out correctly. For this reason, by following

the specifications of the S.A. no alternatives are available as far as the selection is concerned, thus, it will be carried out automatized by a device capable of classify correctly the asparagus.

4.3. Washing

The washing stage in the process of preparing preserved vegetables is very similar and has been described in the previous section of the alternatives to the process technology of preserved peppers. As mentioned, humid washing is used to remove land that is usually found in the roots of the product. While the dry cleaning is to eliminate branches and other elements that accompany products with greater mechanical consistency and lower water content.

4.3.1. Chosen alternative

In this case, as in preserved piquillo peppers, it is decided to choose a wet wash, since the asparagus is a product with a high water content, of a soft character and that may contain residues that must be eliminated with processes wet. In general, washing treatments for fruits and vegetables are washed wet.

4.4. Peeling

Peeling is one of the necessary and most important processes in the transformation of fruits and vegetables. It consists in the elimination of inedible material of each specific food. It is essential that, once the peeling process is finished, the products are clean and have not suffered any type of damage. In the case of asparagus, they do not have skin as in other products, but the layers of the more superficial shoots become stiff due to water stress and are eliminated as if they were skin.

There are different types of peeling, in the case of asparagus, the manual process using knives has been the most used in the food industry. However, automated systems have been developed that simulate this mechanical peeling action. So, regarding the asparagus peeling stage, the alternatives that arise are using a manual method or an automated method.

4.4.1. Chosen alternative

The alternative that is chosen is to use an automated method that simulates the action of the knives to eliminate these superficial layers. Depending on the machine and the heads available, the capacity will be greater or lesser. It is decided by an automated method to obtain a greater quantity of peeled product in less time. In addition, the process is the same as the manual since the automated one has designed it as a simulation of it.

4.5. Blanching

Blanching consists in the application of heat until reaching an elevated temperature for a certain time, but below the sterilization temperatures. This type of treatment does not work as a conservation method but rather as a pre-treatment and preparation of the raw material. The functions of blanching are very diverse, one of the main applications of blanching is the destruction of the enzymatic activity of fruits and vegetables.

The functions of blanching in the asparagus consist fundamentally in the inactivation of enzymes that may cause food deterioration. The blanching is also used to eliminate the occluded gases, thus eliminating oxygen, avoiding possible deterioration reactions. Blanching also facilitates the filling of the containers and also facilitates the production of vacuum in the headspace. Regarding the technology of the process, no alternatives arise at the scald stage. The blanching that will be applied to the asparagus is 3 minutes at 95 °C

4.6. Packaging (can and glass packaging)

The packaging is one of the most important stages in the production cycle of a preserved vegetable as mentioned in the previous section of preserved piquillo peppers. In this stage, the filling and sealing of the containers takes place.

4.6.1. Filling

The alternatives that arise in terms of filling food are whether manual or automated methods are used. Products that present certain difficulties to enter the packaging, or that may be damaged or that must be presented in a certain order to improve the image before the consumer, must be packaged by manual methods.

Chosen alternative

In this case, it is decided to choose the manual method of filling the containers, with the aim of avoiding any damage that the product may suffer since it presents certain difficulties to adapt to automated methods.

4.6.2. Sealing of the cans

The sealing has already been discussed and described in the previous section sealing of the cans in the piquillo peppers section. As in preserved peppers, it is necessary to have a vacuum in the head space of the container to avoid damage due to overpressure or excessive stress that we may subject to the containers. Regarding the sealing, no alternatives arise since the possible options to choose will arise from the machinery that is chosen.

4.7. Thermal treatment

The different thermal treatment options and the objective of each one has been explained in the thermal treatment section of the process technology alternatives about the preserved peppers. In this case, preserved asparagus has an average acidity since its pH is above 4,6. In this case, the treatment must be more severe than pasteurization, so it must exceed 100°C.

4.7.1. Chosen alternative

In this case, in the preparation of preserved asparagus, it is decided to choose a sterilization treatment of the product in order to obtain an F: F 10 121 = 3 minutes. Thus, maintaining the temperature at 121 °C for 3 minutes, the probability of survival of the pathogenic microorganisms can be considered negligible.

4.8. Cooling

The cooling, as in the previous case, is carried out in the same sterilization equipment. Its objective is to reduce the temperature of the containers once they are treated and there are no alternatives available regarding the technology of the process.

4.9. Storage

Regarding the storage stage of the finished product, the same considerations should be taken into account as in the case of preserved piquillo peppers. The storage chambers must be designed taking into account the production volume and the temperature and humidity conditions that the preserved asparagus require.

4.10. Distribution

Finally, as in the previous point, a distribution must be designed to ensure that the product reaches the consumer in good condition and through an efficient system. At this point, there are no alternatives in terms of process technology.

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SCHOOL OF AGRICULTURAL ENGINEERING

Agri-food & Rural Environment Engineering

ANNEX 7. PRODUCTION PROCESS ENGINEERING

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

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In this section of the project is going to describe the alternatives that exist about the production process engineering of the two production lines. The flux diagrams are presented and each of the stages.

2. Flux diagrams of the process engineering

2.1. Canned peppers

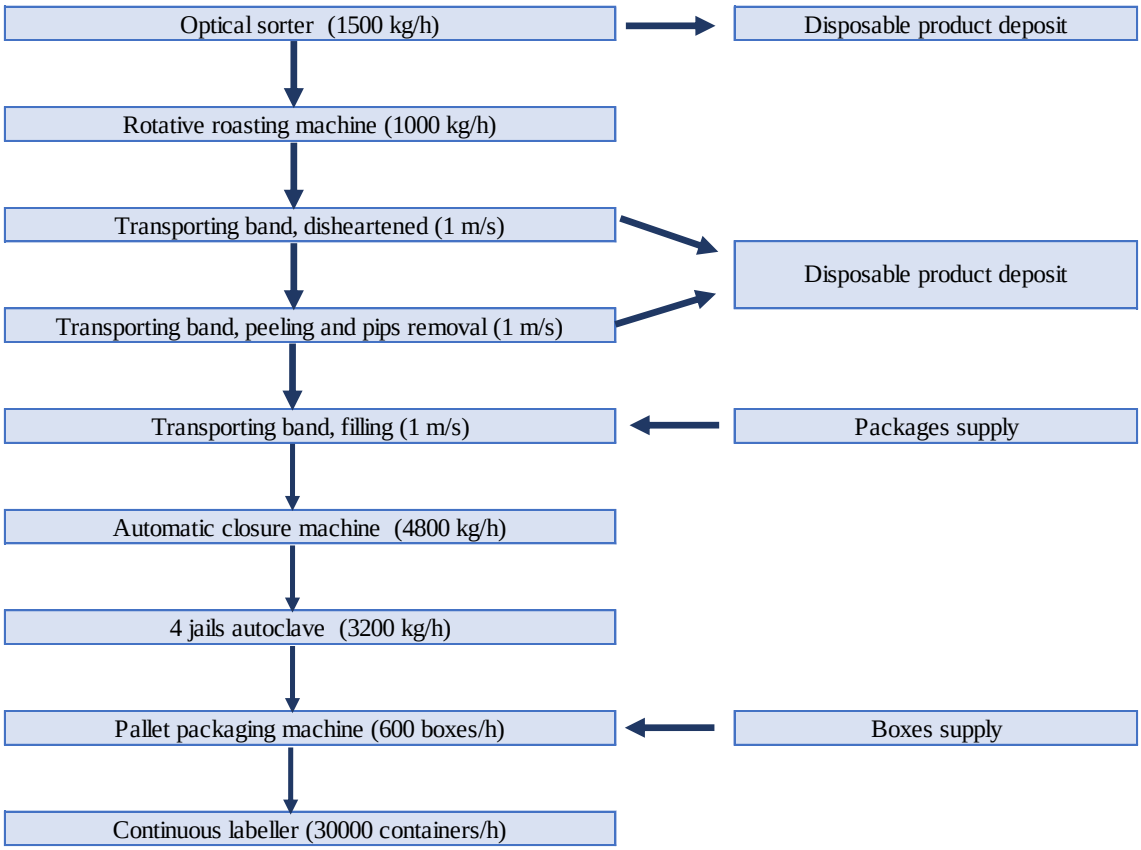


Figure 33: Process engineering flux diagram, canned peppers

2.2. Canned asparagus

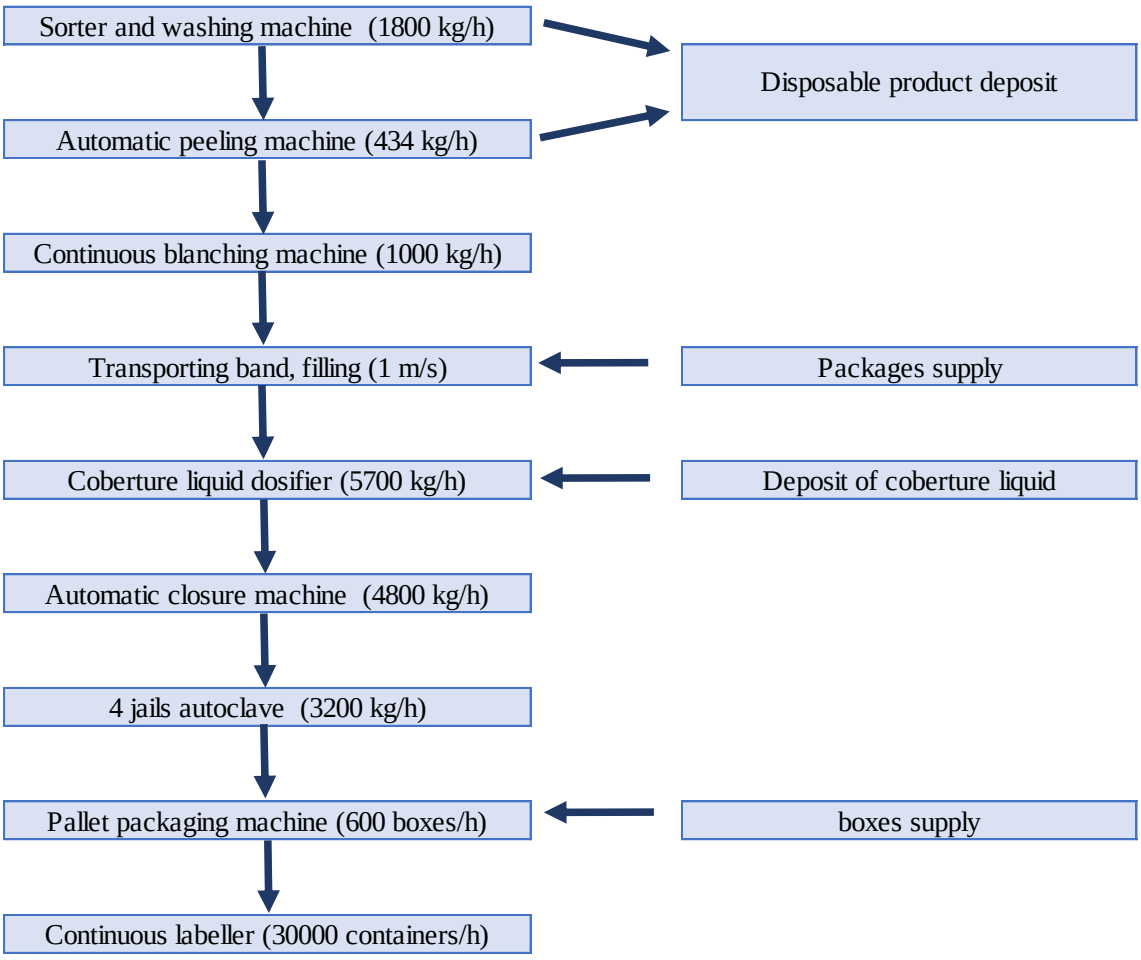


Figure 34: Process engineering flux diagram, canned asparagus

3. Alternatives of the production process engineering: Piquillo peppers

3.1. Reception

The reception of the raw material for the preparation of canned peppers will be carried out at the loading dock and will be placed directly in the process line so that its transformation begins. There are no alternatives to be taken into account at this stage.

3.2. Selection

As mentioned in Annex 6. Process technology, the selection of the product by following the specifications of the D.O. corresponding, will be carried out automatically, using a separating equipment of peppers.

3.3. Roast

Following the specifications of the D.O. of "Pimiento del Piquillo de Lodosa", the roast of the product must be carried out by direct flame on the peppers. Thus, no possible alternatives are available regarding this equipment.

3.4. Disheartened, peeling and pips removal

Peeling the pepper takes place thanks to the roast of the same, which causes the skin to harden and can be removed easily. These three actions on the pepper must be carried out manually following the specifications of the D.O. therefore, no possible alternatives are available. The disheartened, peeled and ginned will be made by the personnel in plant after the roasting stage of the peppers.

3.5. Filling

The materials of the containers that are going to be used in canned peppers are tin and glass.

The tinplate used for the cans is made of a low carbon steel sheet, 0,15-0,50 mm thick, covered on both sides with a layer of tin that rarely exceeds 1% of the total thickness of the tin. The tinplate structure has an oily film, followed by a layer of tin oxide, another layer of tin, an alloy of tin and steel and finally a bed in much thicker than the previous steel only. The characteristics and resistance offered by tinplate depend on the type of steel it presents and its thickness. The appearance and resistance to corrosion depend on the tin coating.

As for glass cans, this is a useful material for food packaging as it is inert to them, impermeable to gases, vapors and gases and, moreover, transparent. This material has an internal surface (in the containers) that facilitates its filling and reuse, however, it breaks against mechanical damages and can not tolerate very abrupt temperature variations. The composition of the glass is mostly silica, followed by calcium, sodium aluminum and potassium in lower percentages.

The glass jars in the case of pepper will have a volume of 314 ml in which a net weight of 290 g and a drained weight of 260 g will be available. In the case of tinplate containers, their capacity will be 425 ml with a net weight of 400 g and a drained weight of 340 g.

The production covered under the D.O. "Pimiento del Piquillo de Lodosa" will be packed in glass bottles, while the production of canned piquillo peppers will be packed in tin cans.

Once the containers that are to be used are described, the packaging methods are presented, which are the following:

3.5.1. Manual

Within all the processes and different methods that exist for packaging, the manual is the oldest and the one that has been used the most in food companies. Manual packaging, nowadays, is used to package foods that present some difficulty to adapt to automated methods or that may suffer some type of damage during packaging. This is the case of peppers that are still packed manually. This type of products, apart from being able to suffer any damage, must appear on the packaging in an orderly manner for the final presentation to the consumer. The product should not be too hot for the workers who are going to handle it to burn their hands. Although the use of gloves is mandatory, this does not allow the handling of hot products throughout the workday. Therefore, the product should be cooled to a temperature that is not considered hot for workers and also does not allow microbial growth.

3.5.2. Automatized

The rest of the products have generally been adapted to automated packaging methods. The packaging by volume is the simplest of the methods to carry it out, especially if the measure to be packed is provided by the same container (580,720 ml ..). In this case all the pieces of the product of the same density will be considered and it will be filled until it overflows by the edge of the container. Once filled, some agitation will be applied to eliminate the excess product from the containers.

Volumetric packaging machines

There are longitudinal or circular volume filling equipment. In the case, of circular volumetric filling equipment the product enters the containers through holes in the table, the quantity is adjusted by agitation as in the case of longitudinal equipment and the product that remains falls to the circular table that is recirculated. Exact filling methods have been developed by means of telescopic funnels that allow to fill the containers without any product. Each funnel is placed on top of each hole in the table and on top of the containers, so that the product passes from the equipment to the funnel. When it is full it passes from the funnel to the container, filling it exactly to its capacity, so that no excess food is produced that must touch the table and be recirculated. These more exact filling equipment will be suitable for cylindrical containers and for parallelepipedic trays.

Weight packaging machines

In addition to the volumetric packaging, packaging by weight is the most used volumetric packaging with a weighing control at the end of it. However, the use of packers by weight directly is not so common, since it may be necessary to be able to apply weight deviations immediately, since, for example, if it is being reduced to a product by pieces, each piece does not It will weigh the same and you want to have such deviations. These teams are called associative weighing systems. The associated weight systems do not work with everything that can be lost and that can remain attached to the surfaces of the equipment due to its characteristics and difficulties. These systems are preferably used in frozen vegetables where these adhesion problems do not exist.

3.5.3. Chosen alternative

In this case, the peppers are going to be packaged following the manual method, since they present certain difficulties to adapt to the automated methods and must be presented in an appropriate way in the containers since part of the production is covered under a brand of extra quality.

3.6. Sealing of the packages

The sealing of the metal containers will be carried out by “sertido”, a process consisting of the following three stages: first, compression of the container with the objective of centering it at the required pressure. Then, the first step of the "rulina" of first operation that has the function of making the edge of the lid stay inside the hook of the body of the container, followed by this step, the "rulina" of the second operation makes it crush the hook against the body so that the desired sealing is achieved. The foundation of a metal can seamer is to achieve a double hermetic seal between the lid and the body of the container. The structure that presents the double closure is the following.

In the case of closed containers, there are almost no alternatives to consider, the different solutions that can be made refer to the type of machinery that is going to be chosen. There is equipment that incorporates filler and seamer joined in the same system or there is the possibility of separating both systems and acquiring for the industry fillers and seamers separately. If you decide to unify both systems, you would have the filling options offered by the supplier, while if both systems are separated you could choose the most convenient option for the product.

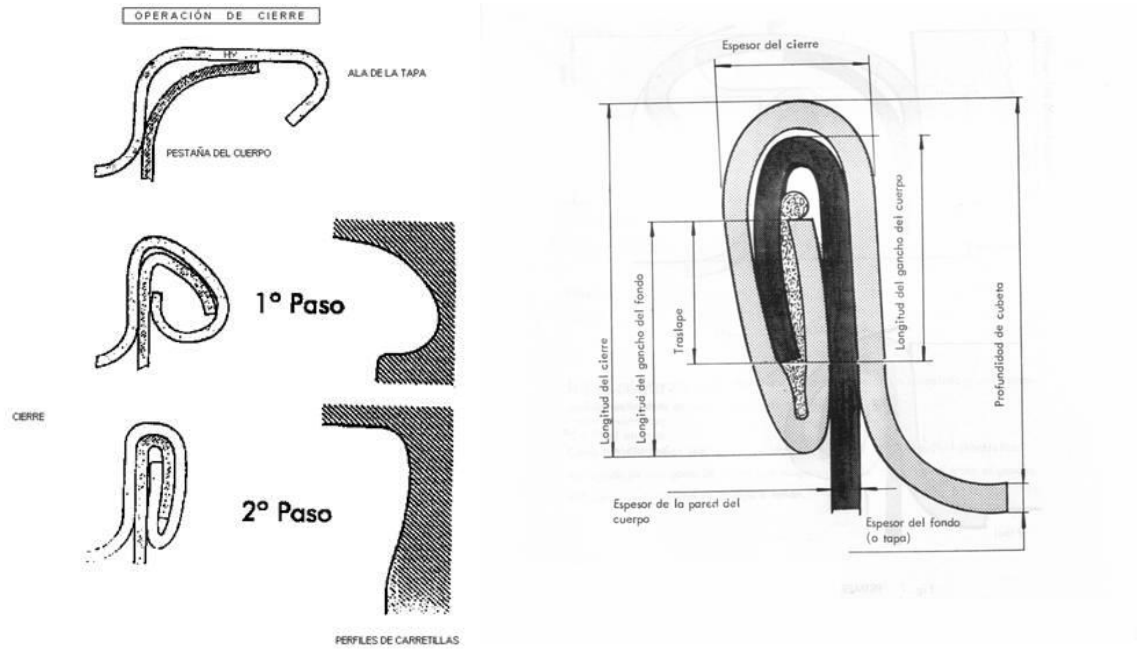


Image 24: Sealing systems of tin containers

In the case of glass containers, the closure of them is totally different. The seamers deposit the lid on top of each container and adjust it with a slight twist. In order for the lid to remain in place, a certain vacuum must exist. This is achieved by evacuating the little air remaining inside before the cap is placed using steam sweep or vacuum application.

3.6.1. Chosen alternative

Metal containers

As for metallic containers for canned peppers, a cylindrical metal can closure equipment is chosen that has 4 closing heads. It is a team that works continuously.

Glass bottles

As for glass containers, a cylindrical can seamer with a range of diameters between 43-160 mm and a height range of 38-260 mm is chosen.

3.7. Thermal treatment: Pasteurization

To carry out the pasteurization process there are different options that can be taken into account, in this section there are alternatives to the problem of choosing the type of machinery required for the thermal treatment of canned products.

In the first place, the first problem that arises is the choice of equipment, autoclaves or continuous sterilizers can be used. Both cases are described with the possible alternatives that arise within each one of them in the following sections. The equipment presented is used both to sterilize canned products and to apply milder treatments such as the pasteurization of peppers. Therefore, sterilization will be mentioned when describing the equipment in general knowing that the peppers are pasteurized.

3.7.1. Autoclaves

Autoclaves are defined as load sterilization systems for packaged foods that consist of a closed enclosure that can be heated to temperatures above 100 ° C. For this reason, these systems must be able to withstand an internal pressure greater than the atmospheric one, and of all the necessary elements to adjust and maintain this temperature during the time necessary for the thermal treatment to be completed. First, the first alternative that arises is the choice of heating fluid that the team will use. Next, the equipment using either saturated steam or superheated water are presented.

Saturated steam

The first equipment that was designed had a cylindrical shape. During the maintenance and heating stage, the internal pressure of the containers was close to that of the enclosure, however, during the cooling stage, problems would arise. These possible problems took place because the cooling was carried out outside, at atmospheric pressure, so that when that stage began there would be a decrease in the pressure of the equipment very sudden, this required the containers have a very high thickness so that they would not cause great damage due to pressure differences.

Saturated steam mixed with compressed air

In order to solve these difficulties, the system was designed to use saturated steam as a heating fluid mixed with compressed air. In the case of combining saturated steam with compressed air requires that a strict homogeneity be maintained during the process since all the containers must undergo the same thermal treatment. Different systems have been developed to achieve this homogeneity in the heat treatment, currently they are commercialized autoclaves that have a fan at one end of the equipment so that a forced convection is produced in the interior and the desired homogeneity is achieved.

This equipment provided with the fan that causes the forced convection inside the equipment have been designed to cause the maximum turbulence so that an acceptable surface exchange coefficient is achieved. To achieve this turbulence in the equipment, two lateral deflectors are available that draw the mixture sucked by the fan to the opposite bottom of the machine, returning it to position in a circular position between the containers, until finally reaching the fan again. The cooling stage in these equipment takes place by water spray coming from the top. The water used for the cooling of the equipment comes from the condensates obtained during the heating stage, supplemented with external water placed in the bottom of the housing before starting the heat treatment. These condensates are cooled by passing them through a heat exchanger. The heating is achieved by injecting steam from the bottom of the machine, which is sucked by the

fan that drives it to the bottom door by the side deflectors to be sucked back and forced to pass between the containers placed in the cages.

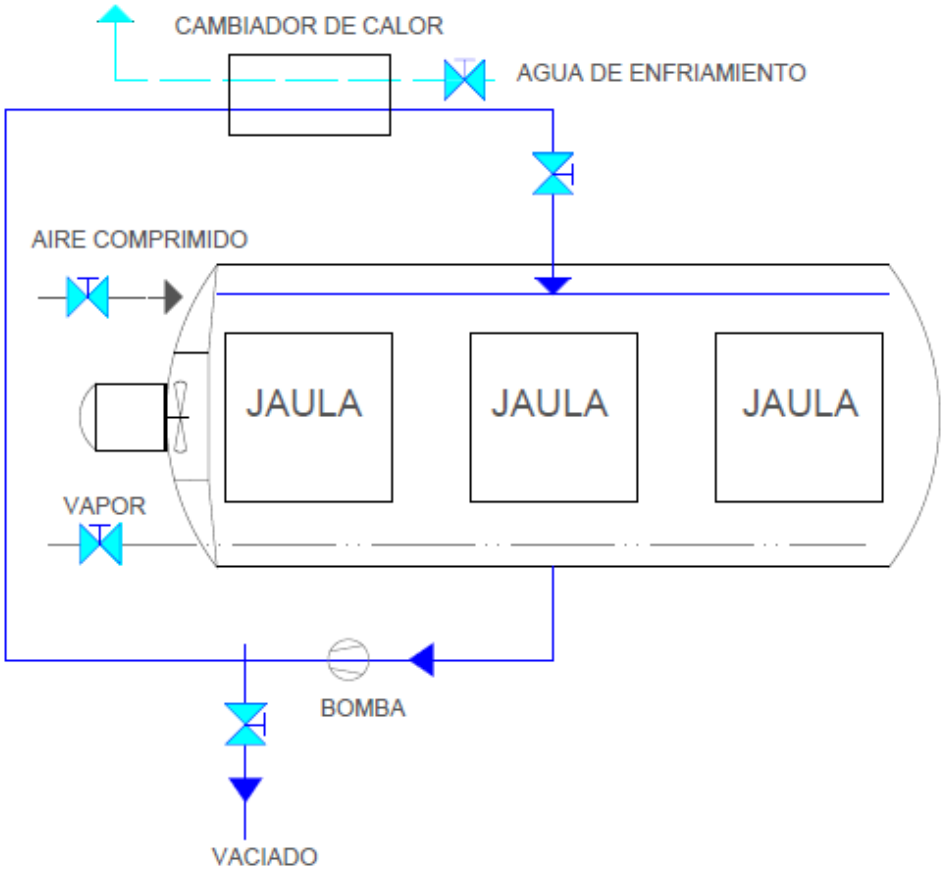


Figure 35: Scheme of a saturated steam mixed with compressed air autoclave

Overheated water

An alternative to the use of saturated steam water is the superheated water maintained at a pressure higher than the saturation of the steam at the working temperature. When overheated water is used in the process, the heating of the product is produced by sensible heat exchange and not by latent heat, as in the case of condensing steam. The coefficient of surface heat transfer is much lower than in the case of steam condensation, and is a function of the speed with which water circulates on the surface to be heated.

Considerations

One of the aspects that must be taken into account when designing and choosing a sterilization equipment is that at all times we must achieve the maximum possible treatment uniformity. This is important regardless of the type of distribution of flow that is applied, in all the systems the heat that is exchanged is sensible heat that is based on the temperature difference, its gradient. Therefore, the containers that are located in the upper part of the cage that receive the water first will be subjected to a different thermal treatment than those placed at the bottom of the cage, since as the water goes through the different containers, this is losing temperature. From here you get that the process temperature is not going to be the same in all the points of the equipment. The way to deal with this situation is to design the equipment so that this difference is reduced to the minimum possible. The way to carry it out is to apply a maximum flow rate that minimizes the cooling of the water during its fall without reducing the amount of heat transferred.

During the application of this process, in the first moments the temperature difference between the container that is in the upper part of the cage and the one that is in the lower part is maximum. This temperature difference is compensated when the temperature of the regime is reached. In the cooling phase, the opposite process will take place, with the water applied in the upper part being cooler than in the lower part. The uniformity of the treatment achieved will depend on the amplitude of the temperature differences and the time that elapses until they are compensated. When the distribution in the cages is homogeneous and the flow of water that is pumped is high enough, the uniformity of the treatments that is reached is quite high, which means that these systems are considered more efficient than the rest of the autoclaves.

The heating by overheated water can be carried out by immersion methods or by water spray. The different alternatives to solution are described.

Immersion

Regarding autoclaves by immersion, the most successful has been the Rotomat, whose structure consists of two cylindrical enclosures located one above the other. In the cylindrical enclosure above hot water is stored, and in the cylindrical enclosure below the cages are arranged with the product to be treated together with the rotation mechanism. In this last enclosure is where the thermal treatment takes place. During the process, the containers rotate in the same vertical plane if the baskets have been loaded vertically. The energy consumed to heat the product and the enclosure is compensated by injecting steam into the flow of water that is recirculated as it passes through a distribution chamber. The water is taken from the lower room through holes, where it is taken to the distribution chamber where it will be heated. By means of this equipment a good distribution of the heat along the containers is achieved, thanks to the rotation and the recirculation of the water. The equipment has a capacity of 1 to 5 baskets and can work up to 45 rpm.

The uniformity of the treatment will depend on the ability of the equipment to maintain a stable temperature during the maintenance period, the coefficient of surface heat transmission and the uniformity of the temperature in any part of the enclosure. In this type of autoclaves the uniformity of the temperature depends on:

- The initial temperature of the product: If the initial temperature of the product is much lower than the temperature of the equipment, it will take more time to complete the cycle. While, if the temperature of the product is close to the regime, the cycle will be faster.
- The stored water temperature: In this equipment, a certain amount of water is stored from one cycle to another at a temperature. This temperature is usually between 15 and 20 °C above the process temperature. This is because if the temperature difference between the initial temperature of the water and the process temperature is very high, the product may suffer damage.
- The size of the containers: The size of the containers influences the resistance that will be offered to the passage of the fluid through them, the smaller the containers, the less space there will be between them and the fluid will have more difficulty in passing between them and the heat transmission will be worse.
- Equipment rotation speed: The higher the speed of the equipment, the shorter the treatment time and the greater the temperature uniformity.
- Equipment size: The larger the size of the equipment, the longer it will take to reach the setting and the lower the uniformity of the temperature.

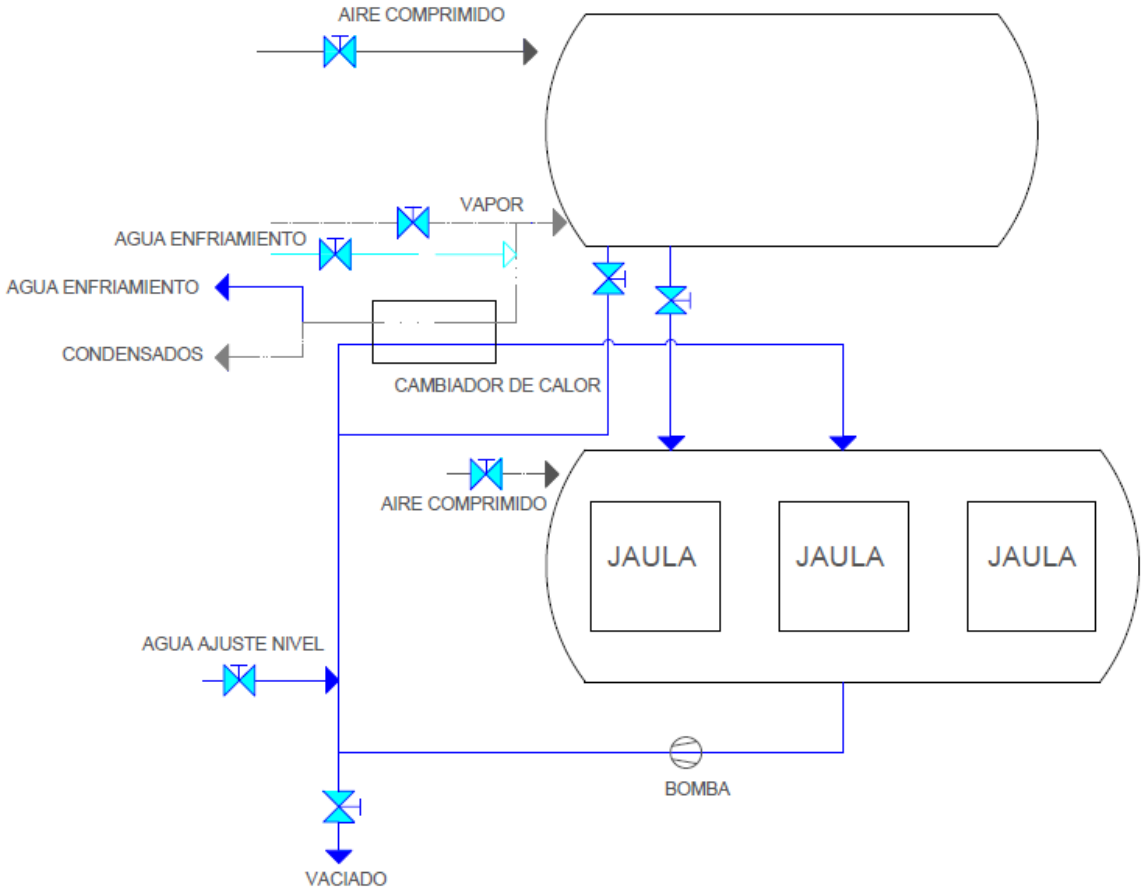


Figure 36: Scheme of an overheated autoclave by immersion

This equipment do not have stages of heating or cooling of the heating fluid, they have an upper tank in which hot water is stored for subsequent cycles. This is due to the fact that in equipment that uses a similar amount of water if the heat of this stored water were lost, the energy expenditure would be very high. This aspect implies that the heat treatment has two different characteristics with the rest of systems that are the following:

- The heating phase of the heating fluid is eliminated, that is, the heating of the food tends to be produced by water at the process temperature.
- When the hot water is removed, the cooling is produced directly by cold water, without the cooling medium gradually reducing its temperature. In order to gradually reduce the temperature, cold water should be mixed with a part of the hot water.

Pulverized water

In this case, equipment that uses water spray instead of immersion methods is based on the transmission of heat to food through a large flow of water that is distributed from the equipment to the product. The volume of water required by these equipment is much lower than the volume required for equipment by immersion. This water is heated indirectly by an external heat exchanger or directly by steam injection. The flow of water is distributed vertically and takes advantage of the outside of gravity to increase its speed and the effectiveness of the treatment. Different methods of water flow distribution have been developed and the following three are those that are commercialized:

- Distribution from a perforated tray
- Distribution from a series of spray nozzles located on the baskets

- Spray distribution by nozzles located above and to the sides of the baskets

The capacity of these equipment is around 6 cages. The direction of the water is perfectly vertical (in the case of the nozzles located on the baskets) and the location of the nozzles is only that which covers the area of the cages. In the case of the perforated tray as a method of distribution, it is technically the best method since the water would be distributed without pressure and would be applied to the entire surface of the containers, however, the uniformity of the treatment will depend on the following aspects:

- Uniformity of the distribution of the holes in the tray
- Uniformity of hole diameters
- Obstruction or not of the holes
- Maintaining the water level in the perforated tray.

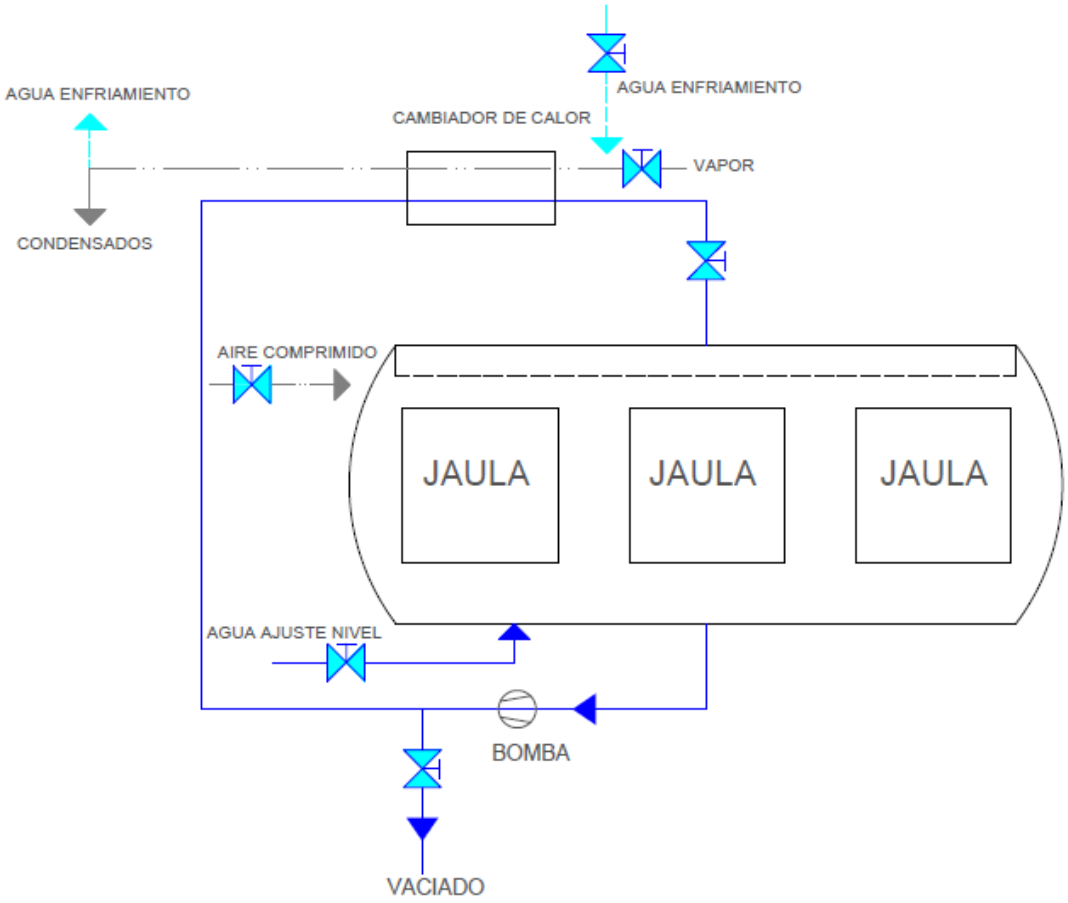


Figure 37: Scheme o an overheated water autoclave by pulverized water

The described autoclaves can work in static or in agitation, the agitation would help to form internal currents that facilitate the exchange of heat. This agitation can be achieved by rotation, by lateral movement or by rocking. Each movement option has its conditions. In the case of rotation, each product will have its turns per minute determined, it can not be the speed of rotation or very small because the movement would not be reached nor very high because the movement would not be reached due to the centrifugal force either.

In addition to the rotation, the horizontal movement is another option to consider and that will have special relevance if the containers are placed horizontally and will also depend on the amplitude and frequency of the movement.

Finally, there is the possibility of applying rocking to the cages, with this method also effective movements and adequate heat penetration are achieved. However, both the balancing and the other two types of movement considerably complicate the design of the sterilization equipment. Agitation is an option to take into account in products with certain difficulties in terms of internal heat transmission, such as foods with a high viscosity.

3.7.2. Continuous sterilizers

The main difference between continuous sterilizers and autoclaves is that the continuous systems have zones at different temperatures that will remain constant throughout the treatment. This means that the product does not heat up and cools because the enclosure that does contains it does so, because it passes from the heating zone to the cooling zone. One of the advantages that can be observed is the energy saving that occurs since in each period it will not be necessary to heat the enclosure in addition to the product, but it will only be necessary to heat the product. The continuous sterilizers reach the start when they start and remain so during the entire treatment. Another appreciable advantage is the uniformity of the treatment, since, since it is not a batch process, the variations that can be found in the temperatures obtained from one product to another are much smaller than in the autoclaves in two different types of cooking.

In these systems the containers go through the interior of the sterilizer in a horizontal position, going from one room to another equipment that are at different temperatures. In Europe, the most successful continuous sterilizer model has been the Hydrolock, a team formed by a horizontal cylindrical chamber where the sterilization and pressure pre-cooling of the containers take place and a system that allows the entry and exit of the containers. to the pressurized room. The chamber is divided into two sections, in one of them the sterilization will take place and in another the cooling. The sterilization is carried out by means of saturated steam or steam-compressed air mixture and the cooling step is produced by immersion in water. In the sterilization section the pressure and temperature is kept constant by the injection of steam and compressed air, while, in the cooling step, the water flow rate is kept constant by the continuous addition of cold water. If required, it can be designed so that the treatment is applied under agitation of the containers.

3.7.3. Chosen alternative

The heat treatment that is going to be applied to the canned peppers is a pasteurization and the equipment that is going to be chosen for the plant in general will be the same, although the treatment is different for one conserves and for another.

Therefore, the equipment chosen for the thermal treatment is a discontinuous system, since they are commonly used in the food industry, in addition to not requiring economic investments so high as to have continuous sterilizers.

Regarding the heating fluid, the autoclaves using superheated water are decided instead of using a mixture of steam with compressed air, since the latter requires a strict homogeneity in the whole equipment so that the whole product has the same thermal treatment. In these teams, the water is distributed from the top of where it will be dropped using the force of gravity to increase its speed. The water as mentioned above will fall on the space where the cages are located only and will slide through the containers thus distributing the heat homogeneously. These teams that use superheated water are much cheaper than those that use saturated steam.

Finally, it is decided to use the method of distribution of the water in the equipment by cascade, that is, the water falls vertically in a perfect distribution, the water falling without pressure and without splashing and sliding down the products located in the cages. A control of the obstruction of the holes in the perforated tray must be carried out so that there are no incidents in the homogeneity and uniformity of the treatment. Lastly, it is decided to choose a device that works

in static, since the products that are going to be sterilized do not require movement for a correct transmission of heat.

It should be noted that two autoclaves are chosen and space is left for a third party in the automatic circuit of the cages thereof in order to have enough space in case the company expands in the future. This can be verified by going to *Drawing 5. Industry distribution layout* in *Document 3. Drawings*.

3.8. Pallets packaging

The palletizing of the containers will take place after their passage through the autoclaves, so that once the order is placed, it will be labeled and it will be shipped. To carry out the palletizing of the products, a palletizing robot with a capacity of 600 boxes per hour is chosen.

3.9. Labelling

The labeling of the products will be carried out once the order is placed. In this way, once the containers leave the autoclaves, the elaborated product will be packaged in pallets and stored.

A continuous labeling equipment with a capacity of 30,000 containers per hour is chosen. This equipment is chosen due to its dimensions since it does not occupy much space and in this way, it does not cause problems to be taken into account in relation to the movement of the personnel.

4. Alternatives of the production process engineering: White asparagus

4.1. Reception

The reception of the raw material for the preparation of canned asparagus will be carried out at the reception dock and will be available directly in the process line so that it begins its transformation. There are no alternatives to be taken into account at this stage.

4.2. Selection and washing

The selection of the product is one of the important stages because if it is not carried out correctly it can end up producing product in poor condition. The selection can be carried out by manual or automatic methods. In this case, as it is also necessary to wash the product, it is decided to choose a team that performs the two tasks.

As discussed in the technology section of the process, the washing stage is one of the most important and has the objective of eliminating the possible contaminants and physical agents contained in the newly harvested food. They are divided into two types of washing, dry washing and wet washing.

4.2.1. Dry washing

Dry cleaning is suitable for the removal of leaves, dust and stones and can be carried out before wet cleaning so as to reduce the load of the latter.

These are processes that are characterized by being cheap and leaving the surface dry, however, they have the disadvantage that if the amount of dust produced is not controlled, there may be a risk of explosion.

Sieve

First, the sieves are equipment for separation by size that could be considered as sorting machines. Starting from its simplest form, a sieve is a perforated plate, supported by a frame. Depending on the size of the pore they will be divided into two groups, those that let the food pass and separate the contaminant or vice versa.

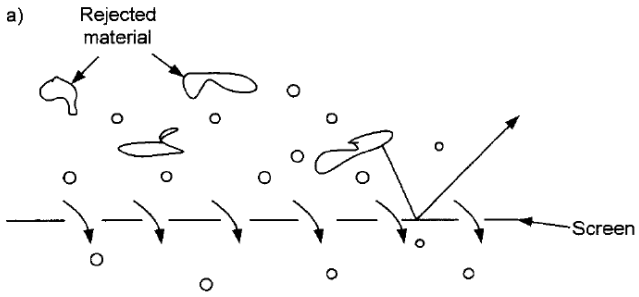


Image 25: Rejected material and food units are allowed to pass through

In addition, there are also those who work allowing the passage of smaller pollutants and blocking the raw material that interests us.

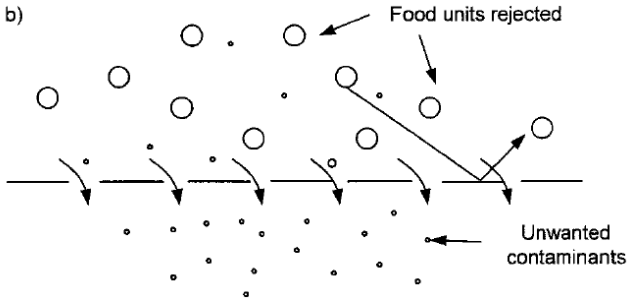


Image 26: Food units are rejected and contaminant material is allowed to pass through

These elementary sieves are being replaced by screens of continuous type such as the drum screen or the flat bed screen.

Rotary drum screens are continuous units that a large number of applications in the food industry. Cleaning can be carried out by retaining large undesirable materials such as ropes or threads to separate them from the food product. Or if not, it can be carried out in a way that retains the clean product and thus discharge the finer undesirable substances. This equipment has a great capacity and are cheap to install and maintain. The disadvantage they present is the difficulty in cleaning which leads to possible contamination.

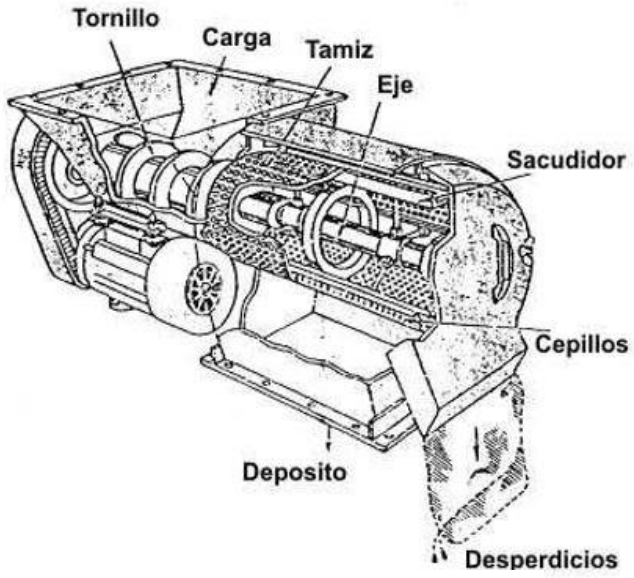


Image 27: Rotary sieve

The flat-bed sieves are generally composed of one or several layers of screens assembled in a dust-tight armature, agitated by different holes. This equipments are excellent for cleaning products such as flour and ground species.

Aspiration

In addition to the sieving methods there are different possibilities to carry out dry cleaning. The methods of aspiration are used mainly in washes of products such as cereals, although it is also currently used in pee and bean washing processes. It consists of placing the newly harvested products in a controlled flow of air at a certain speed that will depend on the size of products that you want to separate. In this way, the denser products will fall and the less dense ones will separate with the air flow depending as it has been commented on the speed of the air flow.

Magnetic methods

Magnetic separators consist of passing the raw material through metal detectors in order to eliminate metal contaminants that are in the raw material due to harvesting. This type of equipment is usually used before applying the heat treatment and at the end of the process lines.

Although the dry cleaning methods are efficient and each has its respective advantages, each also has a type of products for which its use is suitable and the vegetable products derived from fruits or vegetables are normally washed by processes in damp.

4.2.2. Humid washing

Wet washing methods allow the removal of dirt particles that are firmly attached to the product and allows the use of detergents and sanitary products. They are methods that suppose a high economic cost since it is necessary a great amount of clean water and suitable for the use in alimentary processes. In addition, once this water is used, an effluent is obtained, which must be taken care of. Treating the water and reusing it would reduce the expense. They usually add certain chemicals such as chlorine and citric acid.

Immersion

First of all, there is wet washing by immersion in water rafts, which is based on the use of tanks that will be filled with hot water with some detergent to facilitate the elimination of contaminants.

In this way the soil softens and can be easily removed avoiding damage to the machines that are going to treat the food and facilitating its complete transformation.

The deposits used are metal, smooth cement or other construction materials that allow frequent cleaning and disinfection. Absorbent materials such as wood are prohibited. The efficiency of these equipments is increased by displacing the water with respect to the products including agitators, moving the product in the water by means of paddles or feeding with the raw materials a rotating drum partially submerged in the water. You can also shake the water with compressed air, a method that does not damage sensitive products such as asparagus.

Detergents are used more and more and especially in foods that have had applications of phytosanitary products, but we must be careful and apply them as they can cause changes in the organoleptic characteristics of the products. The hot water also facilitates cleaning by immersion, but in turn accelerates the process of food deterioration. Immersion washing is usually considered a pre-stage since it is usually combined with other processes other than wet washing.

Aspersion

Secondly, spray washing is used in a large number of food production lines. The efficiency of the method depends on the volume, the water pressure used, the temperature of the same, the distance of the product to the jet, the time of exposure to water and the number of jets used. In general, applying small volumes of water at high pressure, maximum efficiency is achieved even though the food is exposed to possible damage. In the case of larger foods, it is usually combined with the rotation of the product so that the water is applied to the entire product.

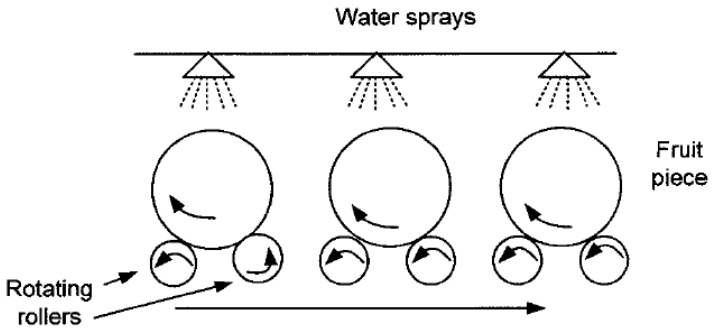


Image 28: Humid washing by aspersion

There are different equipment for washing spray, the application of showers on food would be the simplest of them and has been described in the previous case. Next, the other methods are described. Drum and spray scrubbers consist of a drum of metal bars or rollers separated so as to retain food and allow debris to pass through. The drum rotates slowly in an inclined position. The cylinder has a central spray pipe with heads from which water is dispersed.

The tape and spray scrubbers simply consist of a conveyor belt that moves food under a bank of water sprinklers. In the case of almost spherical products, rollers are used to rotate the products under the showers, and the movement of small pieces of product is carried out by vibratory movements of the conveyor belt.

Ultrasonic cleaning is based on the application of acoustic waves with a frequency higher than that which the human ear can detect, that is, frequencies above 16 kHz. The treatment of a fluid with ultrasonic waves produces a rapidly alternating pressure, in the part of the fluid that the waves go through, giving rise to the formation and rapid collapse of bubbles. Cavitation and implosion results in the release to the system of an energy that violently agitates the submerged particles in the fluid. This method is used to remove contaminants, such as sand in wings,

grease or wax in fruits or faecal remains in eggs. Once the contaminants have been released, they are eliminated by conventional methods. The cleaning by means of this ultrasonic method is used in the industry in general, however, in the food industry it is in the development phase.

Next, a comparative table with the advantages and disadvantages of dry and wet cleaning processes of food processes is presented.

Table 35: Comparison between humid and dry washing methods

Washing methods	Advantages	drawbacks
Dry metho	Low cost of installation	Creates dust
	Dry clean surface	Incomplete removal of land
	Concentrated effluent	Product damage
	Easy equipment cleaning	
	Minimal microbial activity	
Humid method	Total removal of land	accelerate microbial reactions
	Flexible cleaning	Water waste
	Does not creat dust	Creates high volume effluent
	Minimal product damage	Clean humid surfaces that need drying
		Hard cleaning equipment

4.2.3. Chosen alternative

Asparagus is a vegetable preserve, the washing chosen is wet. The chosen equipment works by means of a specific system for the asparagus since it consists of a conveyor belt that orders the turions by means of some pivots and makes them pass underneath the nozzles that by spraying will clean the product.

4.3. Peeling

4.3.1. Mechanical peeling

In the case of asparagus, the peeling to which it has to be subjected is a mechanical peeling. Mechanical methods can be by use of knives or abrasive systems. In the case of asparagus, the most appropriate system is the peeling by use of knives, and the options are the manual or automated system.

The manual is carried out holding the product with one hand horizontally and with the other removing the hardened surface layers. The automated systems that have been developed simulate this activity increasing the effectiveness and speed of the process. The automated equipment consists of a machine with a series of heads, one for each stud and pour it into an individual mold on which the knives adapted to the machine that simulate manual peeling will act. Once finished, the asparagus are moved by a conveyor belt to continue with the production process.

Another type of mechanical peeling is the peeling by abrasive systems, which consists of a cylinder with rough walls and a rotating disc that goes down the central axis of the cylinder allowing the product to go down while it rubs against the rough walls, thus losing the skin. One of the limitations of this type of peeling system is that in many food products it produces more product loss than many other peeling methods.

4.3.2. Thermal peeling

There are other methods of peeling, such as peeling by steam, which involves the application of surface heat on the product in a way that weakens the bond between the pulp and the skin. Once the steam is applied superficially, the food is transferred to a zone of less pressure in which the moisture existing under the skin evaporates, thus cooling the product. Finally, the product is passed through rollers that are responsible for removing the skin. This peeling option requires a more complex installation that has a vacuum pump, a low-pressure blanching machine, a condenser and the necessary equipment to take care of the leftovers and waste left over from the operation. This leads to increasing the economic cost and the need for space available for such installation.

4.3.3. Chemical peeling

Finally, the peeling can also be carried out by chemical means. It is worked with a concentration of caustic soda at 10% and a temperature of 80 ° C. The hot sodium hydroxide has a dissolving effect on the hemicelluloses that form the cellular tissue of union between the dermis and the epidermis of fruits and vegetables. Once the peeling with caustic soda is finished, the products must be washed with water under pressure to remove any remaining sodium hydroxide. The concentration of soda that is being added must be carefully controlled as it is neutralized during the peeling process.

4.3.4. Chosen alternative

In the case of canned peppers, the roasting stage facilitates the removal of the skin from each pepper. In the case of asparagus, manual peeling has been the method that has been most used in the food industry, being a mechanical method for the use of knives. Over the years, automated equipment has been developed that simulates manual mechanical peeling and is capable of peeling several shoots at a time depending on the heads available.

Therefore, the alternative chosen is the automated equipment that simulates the action of manual peeling.

4.4. Blanching

The first alternative that emerges in terms of the blanching stage is the use of heating fluid, hot water or steam.

4.4.1. Hot water immersion

First, scalding by immersion in water consists in passing the food through a perforated drum that revolves around a water tank at a controlled temperature. The speed at which the food passes is also controlled. The scalding temperatures are between 75-100 ° C. Another option to carry out the scaling by immersion in water is to suspend the product in a pool of water at the treatment temperature determined during the established time and then pump it through a tube. These methods require scrupulous cleaning since there is the possibility of contamination by thermophilic microorganisms. In the case of asparagus, one of the ways to improve the quality of the product is to carry out an immersion in a progressive manner so that the treatment applied in the buds that is the softest part of the asparagus is milder than that of the stems.

4.4.2. Blanching by using vapor

Secondly, steam blanching involves using water vapor saturated at low pressure. The pressure to which the steam is applied must be 150 kNm^{-2}. The food is dragged through a steam chamber on a mesh belt or by means of a helical screw. Once the steam has been applied and the product has already been blanched, it is discharged through an outlet valve, moving on to the following sections. This method of scalding involves a smaller amount of losses of soluble solids than scalding by immersion, but it has less cleaning capacity, for this reason it is necessary for the product to be applied a subsequent cleaning system.

The main problems that scalding presents is to apply a uniform treatment, controlling the loss of nutrients throughout the process. One of the functions of scalding is to deactivate the enzymes that can cause negative changes in the organoleptic characteristics of the product and among the most thermostable is peroxidase. This enzyme, being the most thermostable, is used as a reference and, depending on the product being treated, it will be necessary or not to deactivate it completely.

4.4.3. Chosen alternative

For the blanching stage of the asparagus, it is decided to choose hot water as the heating fluid. In this way, the selected equipment allows to immerse the asparagus in hot water leaving the buds free of contact with water. The water that evaporates will act on the buds applying a minor treatment to these. Thus, the treatment will be more specific for each part of the product and the final quality will be much higher.

4.5. Filling

The different methods of packaging have been explained in the point referring to the packaging of canned piquillo peppers within the alternatives to process engineering. Taking into account that asparagus present certain difficulties to adapt to automated methods as well as peppers, it is decided to choose a method of manual packaging by the personnel in plant.

4.6. Government liquid addition

Once the product is packaged, the liquid of government must be added by a liquid dosing machine. The liquid of government can be closed in hot, so that the sterilization or heat treatment to be used is easier, if you add cold, the machine should use a greater amount of energy in heating the containers and take them to the sterilization temperature. In addition, add the hot government liquid and the container with the internal temperatures to the next level of boiling water, when closing it quickly a vacuum is produced in the interior that facilitates the elimination of gases and evacuation.

The cover liquid also has different ways of being added, in the first place, it is not customary to add manually, but the automated methods are used. Within these methods, you can add to reopening or measuring the exact amount for each container.

Another aspect to take into account is the difficulty of presenting the product so that the steering fluid occupies all the air spaces of the container, depending on this, there are equipment that work at atmospheric or vacuum pressure. In the case of the equipment that works at atmospheric pressure, the filling is done through some dispensers, under which the containers pass with the products and to which the steering fluid is added. However, in the case of equipment that works under vacuum, a nozzle is fitted through which at the same time the steering liquid will be added and a vacuum will be produced. This way you can get a quicker and more accurate filling. In case it is a liquid product, the packaging system will be different, but the canned products that are going to be made more liquid, those methods are not taken into account.

4.6.1. Chosen alternative

A liquid dosing device is chosen per curtain. This equipment consists of a belt that carries the containers below the distribution branch of the steering fluid. The quantity is pre-established and regulated by a ball valve located on the branch.

4.7. Sealing of the packages

The containers and the closing systems have been explained in the point referring to the closing of the canned peppers within the alternatives to the engineering of the process. As in the containers that are going to be used in the preparation of canned asparagus are also glass and tin, the alternatives chosen for seamers of both materials are the same for both canned products.

4.8. Thermal treatment: Sterilization

In the case of canned asparagus, the heat treatment to be applied is a sterilization since it has lower acidity than canned peppers. The sterilization methods and equipment together with the alternatives that arise in this stage have been explained in the section on heat treatment of canned pepper within the alternatives to process engineering. As mentioned, the treatment that is going to follow the canned peppers is a pasteurization while the treatment of the asparagus is a sterilization.

In order to make the organization easier of the company it has been decided to choose two teams capable of applying both treatments. The chosen equipment are the autoclaves described in the previous section of Alternatives of the production process engineering: Piquillo peppers in this same document.

4.9. Packaging in pallets

The palletizing stage will be carried out in the same way as in the case of canned peppers, once the products have been heat treated. The same equipment will be used as in canned peppers.

4.10. Labelling

The labeling will take place once the order has been made as in the case of canned peppers. The equipment used is the same since the capacity is sufficient for the two productions.

5. Chosen machinery

5.1. Canned peppers production line

Description		
Sorter based on sensors and pulsed light LED managed from a simple user interface, capable of detecting foreign material, color defects, spots and flaws.		
Dimensions	Length (mm)	1000
	Width (mm)	2748
	Height (mm)	1332
Capacity (kg/h)		1500

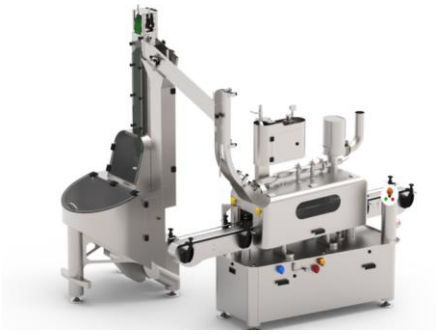
Description		
Rotary roast machine of peppers by direct flame action with hopper of entrance and exit of product. Cylindrical structure and has a security system that detects foreign bodies.		
Dimensions	Length (mm)	5000
	Width (mm)	3000
	Height (mm)	3000
Capacity (kg/h)		1000

Description		
Transporting bands used in the desrorazonado, peeling and ginning of the pepper. Installed in a circular way so that it is an infinite circuit in each stage		
Velocity (m/s)		1

Description		
Closing machine of cylindrical metallic cans with 4 closing heads. Accepts cans with a diameter between 47 and 105 mm and heights from 25 to 120 mm. Finished in stainless steel.		
Dimensions	Largo (mm)	2000
	Ancho (mm)	1024
	Alto (mm)	1763
Capacity (kg/h)		4800

Figure 38: Chosen machinery for the pepper production line 1/2

Description		
Closer of cylindrical glass containers, with an ergonomic design that facilitates the cleaning of the equipment. Designed under the standards of food safety		
Dimensions	Length (mm)	2900
	Width (mm)	2300
	Height (mm)	2620
Capacity (kg/h)		4800



Description		
Discontinuous sterilization systems. They have 4 cages and the diameter of the equipment is 1520 mm. They are connected to an automatic circuit of movement of the cages.		
Dimensions	Length (mm)	4500
	width (mm)	2300
	Height (mm)	2620
Capacity (kg/autoclave)		3200

Description		
Automatic packaging labeling equipment. Designed for the labeling of containers of cylindrical character in the food industry		
Dimensions	Length (mm)	2500
	Width (mm)	1000
	Height (mm)	1800
Capacity (kg/h)		12000

Description		
Packaging in pallets system that is placed in the end of the production process before the labelling		
Dimensions	Length (mm)	5000
	Width (mm)	5000
	Height (mm)	2000
Capacity (Boxes/h)		600

Figure 39: Chosen machinery for pepper production line 2/2

5.2. Canned asparagus production line

Description		
System of washing and selection of asparagus, classifying those of interest for the industry. It consists of two equipment connected by a product conveyor belt. First the asparagus goes through the washing and then it is classified		
Dimensions	length (mm)	10000
	width (mm)	700
	Height (mm)	2000
Capacity (kg/h)		1800


Description		
Automatic asparagus peeling system, designed to simulate the manual peeling action of the product. Number of variable heads.		
Dimensions	Length (mm)	1650
	Width (mm)	1600
	Height (mm)	2000
Capacity (kg/h)		868

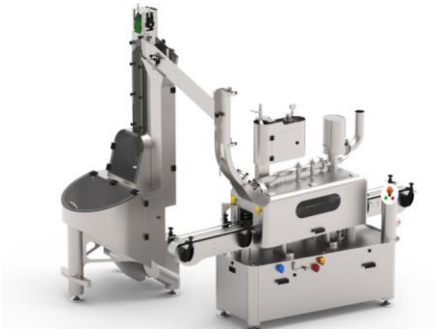
Description		
Blanching equipment by immersing the product in metal cans. It has a system to dump the boats getting the product to communicate with the next team.		
Dimensions	Length (mm)	7000
	Width (mm)	1200
	Height (mm)	1400
Capacity (kg/h)		1000

Description		
Closure equipment for non-circular cans. It has a closing carousel with 5 heads. It is a continuous system of closed containers.		
Dimensions	Length(mm)	4500
	Width (mm)	1925
	Height (mm)	1950
Capacity (kg/h)		6480

Figure 40: Chosen machinery for asparagus production line 1/2

Description		
Discontinuous sterilization systems. They have 4 cages and the diameter of the equipment is 1520 mm. They are connected to an automatic circuit of movement of the cages.		
Dimensions	Length (mm)	4500
	width (mm)	2300
	Height (mm)	2620
Capacity (kg/autoclave)		3200

Description		
Closer of cylindrical glass containers, with an ergonomic design that facilitates the cleaning of the equipment. Designed under the standards of food safety		
Dimensions	Length (mm)	2900
	Width (mm)	2300
	Height (mm)	2620
Capacity (kg/h)		4800



Description		
Packaging in pallets system that is placed in the end of the production process before the labelling		
Dimensions	Length (mm)	5000
	Width (mm)	5000
	Height (mm)	2000
Capacity (Boxes/h)		600

Description		
Automatic packaging labeling equipment. Designed for the labeling of containers of cylindrical character in the food industry		
Dimensions	Length (mm)	2500
	Width (mm)	1000
	Height (mm)	1800
Capacity (kg/h)		12000

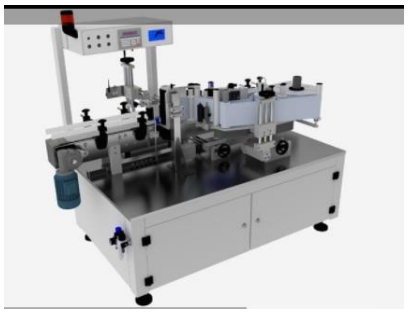


Figure 41: Chosen machinery for asparagus production line 2/2

PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

Public University of Navarre

SCHOOL OF AGRICULTURAL ENGINEERING

Agri-food & Rural Environment Engineering

ANNEX 8. PIPING INSTALLATION

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

March 2018

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1. Introduction

In this point the design and calculation of the piping installation will be described. The beginning of the installation is placed in the general connection with the water supply network of the Industrial park 2 of Lodosa.

The water in the network reaches the connection with a pressure of 2 barg. The barg is a unit of pressure used in this installation, it indicates the relative pressure that a manometer would mark. From this point, the piping network of cold water that will supply the machinery from the production lines that requires water together with the toilets of the personnel and offices is designed.

The pipes will be made of stainless steel approved by the ASME B31.1 standard and will have sections in which it will be buried, other sections that will be stuck to the wall at ground level and others that will have to be supported to a certain height to avoid doors.

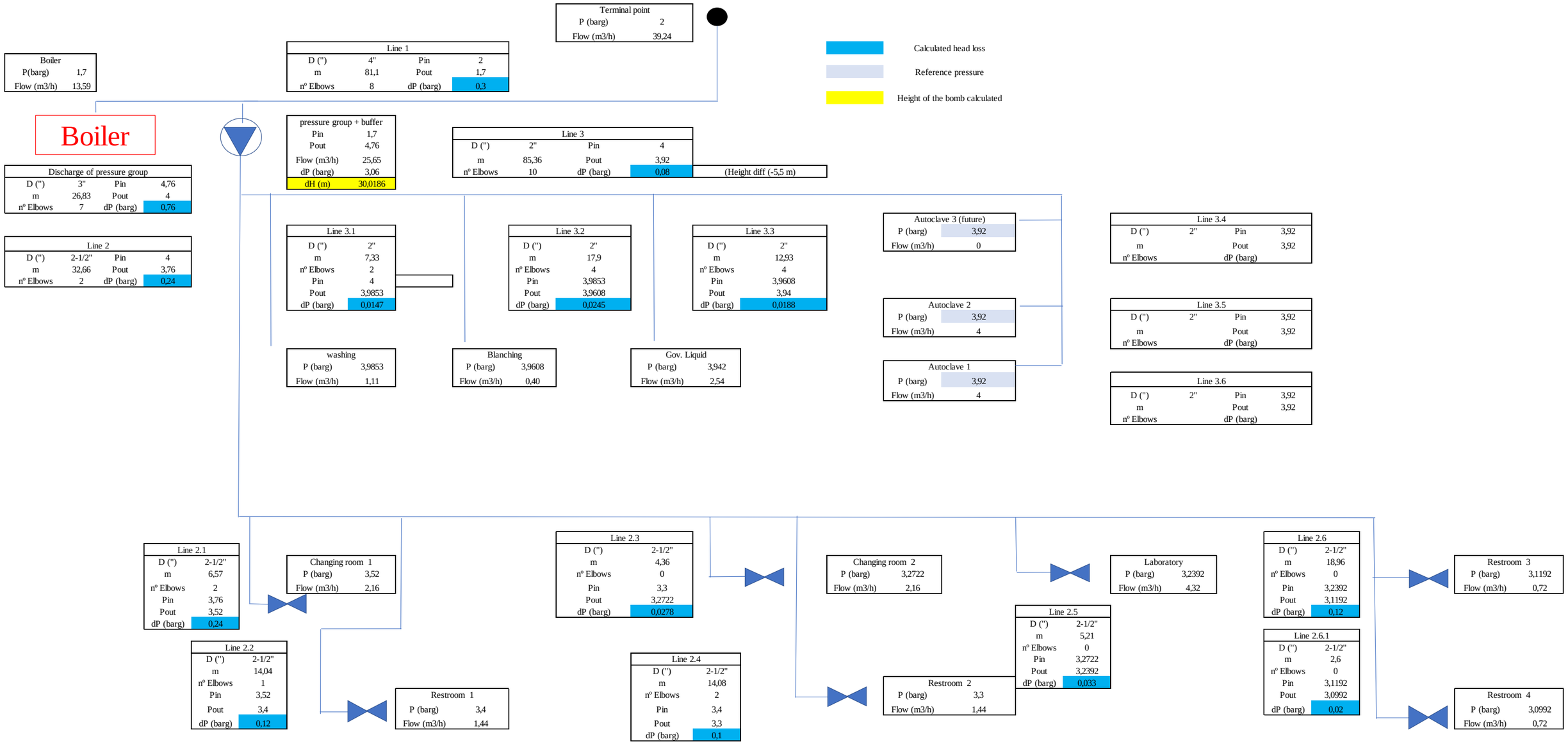
The process to follow for the design and complete calculation begins with the use of the tool Piping and Instrumentation Diagram (P & ID), which consists of a graphical representation in the form of a diagram in which the different pipes that make up each line appear with the data of pressure and diameters of each terminal point of the installation. Assuming terminal point as every machinery or point where water is required, such as bathrooms, changing rooms or the washing machine for the asparagus.

Following the graphical representation of the installation with its study of the pressure, the hydraulic calculations that are presented below of the pipes have been made, calculating their diameters, flow rates and speeds, assuming a maximum water velocity of 2 m/s pipe.

There are two different areas in the building, an area of machinery in which both production lines and autoclaves are located and the second area where the two bathrooms and the two changing rooms are together with the laboratory and the two smaller bathrooms located between laboratory and offices. The piping installation of cold water for both areas has been designed, in addition to the hydraulic calculations of the hot water installation for the bathrooms area, changing rooms and supply steam pipes for the autoclaves.

2. Piping and Instrumentation Diagram (P&ID)

Through the P&ID an outline of the installation with the consumers is represented. Then, an estimated layout of the pipes in the plant has been made, thus it has been possible to estimate meters of pipe along with elbows and tees. With this information you can calculate the head losses at any point of the installation. In this scheme, the information of the dimensioning of the pipes that is presented in the hydraulic calculations is implemented.


Terminal point
P (barg) 2
Flow (m3/h) 39,24
Boiler
P(barg) 1,7
Flow (m3/h) 13,59
Line 1
D (") 4" Pin 2
m 81,1 Pout 1,7
nº Elbows 8 dP (barg) 0,3
Calculated head loss
Reference pressure
Height of the bomb calculated
Boiler
pressure group + buffer
Pin 1,7
Pout 4,76
Flow (m3/h) 25,65
dP (barg) 3,06
dH (m) 30,0186
Line 3
D (") 2" Pin 4
m 85,36 Pout 3,92
nº Elbows 10 dP (barg) 0,08
(Height diff (-5,5 m)
Discharge of pressure group
D (") 3" Pin 4,76
m 26,83 Pout 4
nº Elbows 7 dP (barg) 0,76
Line 2
D (") 2-1/2" Pin 4
m 32,66 Pout 3,76
nº Elbows 2 dP (barg) 0,24
Line 3.1
D (") 2"
m 7,33
nº Elbows 2
Pin 4
Pout 3,9853
dP (barg) 0,0147
Line 3.2
D (") 2"
m 17,9
nº Elbows 4
Pin 3,9853
Pout 3,9608
dP (barg) 0,0245
Line 3.3
D (") 2"
m 12,93
nº Elbows 4
Pin 3,9608
Pout 3,94
dP (barg) 0,0188
Autoclave 3 (future)
P (barg) 3,92
Flow (m3/h) 0
Autoclave 2
P (barg) 3,92
Flow (m3/h) 4
Autoclave 1
P (barg) 3,92
Flow (m3/h) 4
Line 3.4
D (") 2" Pin 3,92
m Pout 3,92
nº Elbows dP (barg)
Line 3.5
D (") 2" Pin 3,92
m Pout 3,92
nº Elbows dP (barg)
Line 3.6
D (") 2" Pin 3,92
m Pout 3,92
nº Elbows dP (barg)
washing
P (barg) 3,9853
Flow (m3/h) 1,11
Blanching
P (barg) 3,9608
Flow (m3/h) 0,40
Gov. Liquid
P (barg) 3,942
Flow (m3/h) 2,54
Line 2.1
D (") 2-1/2"
m 6,57
nº Elbows 2
Pin 3,76
Pout 3,52
dP (barg) 0,24
Changing room 1
P (barg) 3,52
Flow (m3/h) 2,16
Line 2.3
D (") 2-1/2"
m 4,36
nº Elbows 0
Pin 3,3
Pout 3,2722
dP (barg) 0,0278
Changing room 2
P (barg) 3,2722
Flow (m3/h) 2,16
Laboratory
P (barg) 3,2392
Flow (m3/h) 4,32
Line 2.6
D (") 2-1/2"
m 18,96
nº Elbows 0
Pin 3,2392
Pout 3,1192
dP (barg) 0,12
Restroom 3
P (barg) 3,1192
Flow (m3/h) 0,72
Line 2.2
D (") 2-1/2"
m 14,04
nº Elbows 1
Pin 3,52
Pout 3,4
dP (barg) 0,12
Restroom 1
P (barg) 3,4
Flow (m3/h) 1,44
Line 2.4
D (") 2-1/2"
m 14,08
nº Elbows 2
Pin 3,4
Pout 3,3
dP (barg) 0,1
Restroom 2
P (barg) 3,3
Flow (m3/h) 1,44
Line 2.5
D (") 2-1/2"
m 5,21
nº Elbows 0
Pin 3,2722
Pout 3,2392
dP (barg) 0,033
Line 2.6.1
D (") 2-1/2"
m 2,6
nº Elbows 0
Pin 3,1192
Pout 3,0992
dP (barg) 0,02
Restroom 4
P (barg) 3,0992
Flow (m3/h) 0,72

The objective of using the P&ID is to make a study of the pressure required at each point, thus it is observed that the water supplied by the distribution network has 2 barg of pressure and the sterilization equipment needs 3,92 barg. That is why, a pressure group is required for the cold water circuit.

In order to calculate the pressure group that is required, the pressure loss that is available from the pressure group to the autoclave is calculated, since the reference pressure used is that of this equipment. To this pressure of the equipment will be added the loss of load generated by the pipe to the pressure group. In this way, the Pin and Pout of the pressure group will be obtained, thus knowing the pump that is required. Being Pin the pressure just before the pressure group and the Pout the pressure right after it.

In order to calculate the head loss till the autoclave, the height differences have been taken into account, assuming that the pipe, when it leaves the machine room, is at a height of 1,5 meters, ascends to a false ceiling at a height of 6 meters by which it circulates until arriving at the production area where it rises up to a height of 8 meters, so that it can cross the door and reach the machinery. So as to reach the autoclave, it descends a height of 2,5 meters. In the global calculation of the slope, there is 1 meter of ascent and 6,5 of descent, for this reason, the difference in elevation benefits the installation in 5,5 meters in terms of the head loss. The height differences data is applied in the head loss of the pipe to the autoclave to know the pressure in the discharge of the pump.

Once the pressure group has been calculated, the pressures with which the water will reach the bathrooms and changing rooms have been calculated too. The collector of the bathrooms and changing rooms has been connected to the pressure group.

Although the pressure of the distribution network would have been sufficient for the bathrooms and changing rooms, the installation of an emergency shower in the laboratory that requires a pressure of between 2-8 barg according to the Regulation EN15154-1-2 has been taken into account, that is the European standard that regulates safety showers. This ensures a pressure greater than 2 barg for the emergency shower.

In the scheme, the bathrooms located next to the changing rooms have been taken as Bathroom 1 and Bathroom 2, and the bathrooms that are located next to the offices and the laboratory as Bathroom 3 and Bathroom 4. The equipment that requires a lower pressure of the that comes with this installation, will be used pressure reducing devices to prevent damage.

3. Hydraulic calculus

In this section of the hydraulic calculations of the installation, firstly is to locate the consumers of the installation and the the flow and pressure required in each of the terminal points. Taken into account this flow and assuming an initial linear velocity of water of 2 m/s, the internal, external and nominal diameters have been calculated. Once the diameters have been selected, the velocity has been recalculated so that it is between 0 and 2 m/s. The terminal points will be placed in a line or general collector, thus, there will be a collector for the machinery area and another collector for the bathrooms, changing rooms and laboratory.

It is assumed drainage of the machines and drainage by gravity since it will not be pumped. In addition, there are certain terminal points of the installation in which the required pressure with which the water has to reach is not taken into account, since they have a pump that recirculates the water with the necessary pressure. Valves are not dimensioned in the terminal points since the machinery itself has valves with which they connect to the lines.

The table from which the nominal, internal and external diameters used have been obtained is presented. Table taken from "Aceros y Suministros S.A."

Table 36: Standard diameters used

DN [mm]	DN [in]	D int [mm]	D ext [mm]	Espesor [mm]
15	1/2"	15,76	21,3	2,77
20	3/4"	21,16	26,9	2,87
25	1"	26,94	33,7	3,38
40	1-1/2"	40,94	48,3	3,68
50	2"	52,48	60,3	3,91
65	2-1/2"	65,68	76	5,16
80	3"	77,92	88,9	5,49
100	4"	102,26	114,3	6,02
150	6"	154,08	168,3	7,11

3.1. Cold water

3.1.1. Autoclaves

There are two autoclaves and a space for a possible third autoclave in the automatic cage circuit. This equipment has a requirement for process water and cooling water with different flow rates, and also have a steam requirement, so three different terminal points have been determined.

Table 37: Cold water hydraulic calculus, autoclave 1

Autoclave	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Cooling water	4000	3,64	4	3,92	2	7200	25,36	40	40,94	1-1/2"	0,77
Process water	750	0,68	4	3,92	2	7200	10,98	25	26,94	1"	0,33

There are two autoclaves in the industry, they are two teams that are the same and work in the same way, so the hydraulic calculation is the same for the second team. As has been mentioned, two terminal points have been determined by autoclave, these two points are joined in a specific collector for each autoclave, which will be joined to the general collector as well as the rest of the terminal points of the machinery area.

Table 38: Cold water hydraulic calculus, autoclave collector

Autoclave collector	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Water		4,32	-	-	2	7200	27,63	40	40,94	1-1/2"	0,91

3.1.2. Government liquid dispenser

The government liquid dosing machine located before the glass and metal sealers. In this case the required pressure is not taken into account because the equipment has a pump that will apply necessary pressure to the water.

Table 39: Cold water hydraulic calculus, government liquid dispenser

Government liquid	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Suministro de Water	-	2,54	-	-	2	7200	21,19	25	26,94	1"	1,24

3.1.3. Blanching machine

In this case, the equipment has its own water circulation pump, so the pressure is not taken into account.

Table 40: Cold water hydraulic calculus, blanching machine

Blanching machine	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		0,40	-	-	2	7200	8,41	20	21,16	3/4"	0,32

3.1.4. Asparagus washing machine

Table 41: Cold water hydraulic calculus, asparagus washing machine

Asparagus washing	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		1,11	-	-	2	7200	14,03	20	21,16	3/4"	0,88

3.1.5. Changing room 1

In the case of changing rooms and bathrooms, taps showers and toilets are available. In each dressing room there are 3 showers and 3 faucets, and in each bathroom 3 toilets and three taps so they have had to take into account coefficients of simultaneity. The coefficients of simultaneity for bathrooms and changing rooms are 0,67, while the office bathrooms have only one toilet and tap is 1. In the case of the laboratory, there are 3 faucets and an emergency shower, the coefficient of the emergency shower is 1.

Table 42: Cold water hydraulic calculus, changing room 1

Changing room 1	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		2,16	-	1	2	7200	19,54	25	26,94	1"	1,05

3.1.6. Changing room 2

Table 43: Cold water hydraulic calculus, changing room 2

Changing room 2	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		2,16	-	1	2	7200	19,54	25	26,94	1"	1,05

3.1.7. Restroom 1

Table 44: Cold water hydraulic calculus, restroom 1

Restroom 1	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		1,44	-	1	2	7200	15,96	20	21,16	3/4"	1,14

3.1.8. Restroom 2

Table 45: Cold water hydraulic calculus, restroom 2

Restroom 2	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		1,44	-	1	2	7200	15,96	20	21,16	3/4"	1,14

3.1.9. Restroom 3

Table 46: Cold water hydraulic calculus, restroom 3

Restroom 3	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		0,72	-	1	2	7200	11,28	20	21,16	3/4"	0,57

3.1.10. Restroom 4

Table 47: Cold water hydraulic calculus, restroom 4

Restroom 4	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		0,72	-	1	2	7200	11,28	20	21,16	3/4"	0,57

3.1.11. Laboratory

Table 48: Cold water hydraulic calculus, laboratory

Laboratory	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		4,32	-	2	2	7200	27,64	40	40,94	1-1/2"	0,91

3.2. Hot water and steam

In this section the tables with hot water calculations and steam pipes for autoclaves are presented. The rest of the equipment that needs water, the washing, blanching and government liquid dispenser machine have their own devices to heat the water.

The hot water circuit is not calculated due to the fact that in this case the boiler or boiler group should be dimensioned. The hot water circuit consists of three parts, the heating, the steam required by the consumer (autoclave) and the domestic hot water. The necessary flow of domestic hot water and steam has been calculated because it is part of the total flow that is taken from the distribution network. Therefore, the boiler or group of boilers must be composed of as many parts

as necessary to provide the necessary pressure in the consumer and bathrooms and changing rooms, and must have a pump for circulation of the closed heating circuit.

3.2.1. Changing room 1

Table 49: Hot water hydraulic calculus, changing room 1

Changing room 1	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		1,19	-	1	2	7200	14,49	25	26,94	1"	0,58

3.2.2. Changing room 2

Table 50: Hot water hydraulic calculus, changing room 2

Changing room 2	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		2,16	-	1	2	7200	19,54	25	26,94	1"	1,05

3.2.3. Restroom 1

Table 51: Hot water hydraulic calculus, restroom 1

Restroom 1	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		1,44	-	1	2	7200	15,96	20	21,16	3/4"	1,14

3.2.4. Restroom 2

Table 52: Hot water hydraulic calculus, restroom 2

Restroom 2	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		1,44	-	1	2	7200	15,96	20	21,16	3/4"	1,14

3.2.5. Restroom 3

Table 53: Hot water hydraulic calculus, restroom 3

Restroom 3	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		0,72	-	1	2	7200	11,28	20	21,16	3/4"	0,57

3.2.6. Restroom 4

Table 54: Hot water hydraulic calculus, restroom 4

Restroom 4	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		0,72	-	1	2	7200	11,28	20	21,16	3/4"	0,57

3.2.7. Laboratory

Table 55: Hot water hydraulic calculus, laboratory

Laboratory	Flow [L/cycle]	Flow [m3/h]	Pressure [kg/cm2]	Pressure [barg]	Theoretical velocity [m/s]	Theoretical velocity [m/h]	Theoretical inner diameter [mm]	Chosen nominal diameter [mm]	Real inner diameter [mm]	Chosen diameter [in]	Real velocity [m/s]
Consumption		4,32	-	2	2	7200	27,64	40	40,94	1-1/2"	0,91

4. Pressure group chosen

Taking into account the hydraulic calculations and the pressure results obtained in the P&ID, it is concluded that a 30,018 m high pump is required. A safety factor of 5% is applied to the flow and 10% to the pressure difference that must be applied, so that a pressure height of 33,02 meters is obtained.

Therefore, one goes to a supplier and the following pump model is chosen. The chosen equipment consists of two pumps together with a pressure accumulator tank that helps prevent water

Tabla 55: Chosen pressure group

TIPO BOMBA	POTENCIA NOMINAL	Q = CAUDAL												
		l/min 0	167	267	340	367	467	540	660	700	800	860	920	967
		m3/h 0	10	16	20,4	22	28	32	39,6	42	48	52	55	58
	kW	H = ALTURA TOTAL METROS COLUMNA DE AGUA												
15SV01F011T	2 x 1,1	14		12,9	12,4	12,2	11,3	10,4	8,4	7,6	5,1			
15SV02F022T	2 x 2,2	29		26,7	25,9	25,5	23,9	22,4	18,9	17,4	13,1			
15SV03F030T	2 x 3	43		40,4	39,1	38,6	36,2	33,8	28,7	26,5	20,1			
15SV04F040T	2 x 4	58		54,7	53,1	52,5	49,4	46,3	39,7	36,9	28,7			
15SV05F040T	2 x 4	73		67,8	65,8	65,0	61,0	57,1	48,7	45,2	34,9			
15SV06F055T	2 x 5,5	88		81,5	79,4	78,4	74,1	69,9	60,3	56,3	44,2			
15SV07F055T	2 x 5,5	102		94,5	91,9	90,8	85,7	80,6	69,4	64,7	50,5			
15SV08F075T	2 x 7,5	117		110,9	108,0	106,8	100,8	94,9	82,0	76,7	60,6			
15SV09F075T	2 x 7,5	132		124,4	121,0	119,6	112,8	106,1	91,5	85,5	67,4			
15SV10F110T	2 x 11	148		138,8	135,3	133,8	126,7	119,6	103,9	97,4	77,5			

PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

Public University of Navarre

SCHOOL OF AGRICULTURAL ENGINEERING

Agri-food & Rural Environment Engineering

ANNEX 9. REFRIGERATION INSTALLATION

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

March 2018

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1. Introduction

In this industry they are going to prepare canned peppers and asparagus. Of these two products, the asparagus is taken as a reference for the design of the cold room for the following reasons:

Pepper is a summer crop and temperatures below 7°C do not benefit you. The storage temperature conditions are between 8-10°C. However, growing asparagus requires lower temperatures for optimal storage. The temperature ranges that the asparagus requires for its storage are between 0-2 ° C and with a relative humidity close to 100%. For this reason the stud is chosen as a reference for the design of the camera.

The asparagus can undergo certain modifications that reduce its quality during the conservation period. For example, it may suffer hardening of the shoots, appearance of curvatures or loss of flavor and aroma. These modifications lead to a decrease in the edible portion and to changes in the composition of negative character, that is directly economic losses.

Taking into account the location of the project, Lodosa, the design temperature to be taken into account for the design is 31.6 ° C, a relative humidity of 34% and a ground temperature of 22.35 ° C.

The designed camera will work 18 hours and a 10% coefficient of mayoration is applied in order to ensure the capacity of the camera. The refrigerant fluid to be used is R-134a, which despite having certain problems regarding the greenhouse effect, the rest of the cooling fluids are still in experimental phases.

2. Design of the raw material storage chamber

2.1. Characteristics of raw material

The characteristics of the raw material that have been taken into account to carry out the design of the storage chamber are presented.

Table 56: Characteristics of raw material

Denomination	Asparagus
Storage density (kg/m3)	140
Freezing temperature (°C)	-1,5
Cp before freezing (kJ/kg°C)	3,94
Latent heat of freezing (kJ/kg°C)	250
Cp after freezing (kJ/kg°C)	2,09
Respiration heat at 25°C (kJ/kgdía)	13,82
Respiration heat at 0°C (kJ/kgdía)	0,84

The capacity of the chamber that is required is 15 tons in this way production is covered for 3 days, the percentage of daily intake of product is 33,3% and at a temperature of 30°C. A weight of the pallets is assumed to be 5%. With the presented data the following constructive characteristics are obtained.

2.2. Constructive features

The dimensions of the raw material storage chamber will be 6,4 m long by 4,4 m wide and 4 m high. That is, a necessary surface area of 28,16 m^2.

The characteristics of the enclosures for the walls, ceilings and the floor, must be such that the density of the thermal flow through them must be less than 8 W/ m2 taking into account the Royal Decree 138/2011, of February 4, by which the Safety Regulations for refrigeration facilities and their complementary technical instructions are approved. To meet this condition, the following enclosures are chosen.

Table 57: Constructive features of the chamber

Chamber side	Material	Thickness (cm)	Conductivity ($W/m^2 °C$)	Heat losses (W/m^2)
Walls and ceiling	Expanded polyurethane *	10	0,2222	7
Floor + insulating	Concrete + expanded polyurethane in plates	12 + 5,5	0,4464	7,1

* Sandwich panel with polyurethane insulation, the metal part can be made of steel or aluminum and is not taken into account for heat conduction calculations.

2.3. Calculus

The calculations of the chamber are carried out taking into account a series of charges that cause loss in the power since they generate a certain amount of heat that the camera has to be able to solve.

In the first place, the charge for renewal of air that will be normal is considered, that is, opening of doors for the entry of personnel or product and not considering very long opening times. The volume of renewed air will be 39,6 m3 / h and its conditions will be 32°C and 34% relative humidity.

Secondly, the load is considered by persons, personnel in plant that work is in the camera, in this case two people are considered.

In third place, the charge for illumination of the camera is considered, in this case 8 W/m2 are considered. Finally, it is also considered loads by fans and by the presence of machines or motors.

2.4. Results

Taking into account the data presented in the previous points, the following calculations are obtained:

Table 58: Charges of the chamber

	Loads	Thermal power	
Installation	Air renovation	0,64	kW
	Personnel	0,54	kW
	Illumination	0,23	kW
	Ventilators	0,68	kW
	Walls and ceiling	1	kW
	Machines and engines	0,75	kW
	Total	3,84	kW
Product	Product cooling	6,84	kW
	Product respiration	1,02	kW
	Pallets cooling	0,236	kW
	Total	8,126	kW

Table 59: Final results of the chamber calculations

Final results	Thermal power	
Total load of the chamber	12	kW
Total load of the chamber majored	13,2	kW
Rerigeration power of the chamber, working 18 h	17,5	kW
Installed power per m^3	156	W/m^3

2.5. Machinery

Once the camera to be installed has been designed, the powers required for the equipment have been calculated. Some data have been considered taking into account the location of the project, evaporation temperatures, yields, etc. The teams chosen taking into account these powers are the following:

2.6. Evaporator

The chosen equipment is an industrial cubic type evaporator equipped with pre-wired electronic regulation and control valves, for high, medium and low temperature refrigeration chambers, built in galvanized steel structure and body with thermosetting polyester paint. It is the model MKH-NY-1245 that has a cooling capacity of 17,7 kW.

2.7. Compressor

The chosen equipment is a semi-hermetic compressor, model 10GR50.3X R-134. It works with the R-134a refrigerant fluid that is chosen for this cold installation. Presents a power of 10 C.V. and a displacement volumetric flow of 49.88 m^3/h. In the calculations of the refrigeration cycle in which the power needs of the equipment have been obtained, a volumetric flow in the compressor of 39,72 m^3/h has been obtained, the compressor chosen has the capacity for a higher flow rate. It's appropriate.

2.8. Condenser

The equipment chosen is not a silent condenser and is the CBN 29 model, which consists of a single fan and has a power of 28.5 kW. It has the capacity to move a volumetric flow of 6300 m^3/h.

3. Pipes calculations

Regarding the calculation of pipes, certain limiting data that each one of the three pipes that have been calculated must accomplish. First of all, in the suction pipe the speed of the cooling fluid must be between 3-4 m/s if it is a horizontal or descending section. However, if it is an ascending section it must be between 7-8 m/s. The load losses must be less than 1°C.

Second, in the discharge pipe, the calculated speed of the cooling fluid must be between 15-20 m/s and the load losses, as in the previous case, must be less than 1°C.

Finally, in the liquid line, the speed of the cooling fluid must be between 0,5-1 m / s and in this case, the load losses must be between 0,5-1 ° C. These limits allow to reject the options not recommended for the installation and taking them into account the following pipes have been chosen that are presented in a summary table with the main characteristics. These are considerations to take into account in halogenated refrigerant fluids.

Table 60: Final results of the pipes calculations

Denomination	Material	Fluid v (m/s)	Accessories head loss (Pas)	Friction factor
Refrigerant	DN (")	Head loss (°C)	Density (kg/m3)	
Pipe type	Real Length (m)	Head loss (kg/cm2)	Absolut rugosity	Recommended
XV	Internal D (mm)	Head loss by height	Reynolds number	
Aspiration of raw material chamber	Copper (standard bars)	3,472	0,001902	0,01517
R-134a	1,65"	0,04616	0,002426	
Aspiration	13,65	0,004328	400	Recommended
1	63,38	0	24,35	
Aspiration of raw material chamber	Copper (standard bars)	10,46	0,05929	0,01364
R-134a	0,8"	0,5603	0,1107	
Discharge	4,8	0,17	400	Recommended
1	17,45	0	7,371	
Aspiration of raw material chamber	Copper (standard rolls)	0,3656	0,006109	0,02076
R-134a	1"	1,569	0,01334	
Liquid	16,95	0,4704	400	Recommended
1	20,22	0,451	24,71	

PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

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ANNEX 10. PLANNING AND CONTROL OF THE PROJECT EXECUTION

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

March 2018

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1. Introduction

One of the most important points of a project is the planning of its execution. In this case, the project is the design of the processing system of a canning industry, therefore, it is necessary to take into account the time necessary to carry out the activities corresponding to the project so that the company can begin to produce the preserves.

To carry out an adequate control, the tool of the Gantt chart is used, in this case applied through the Microsoft Project 2010 computer program. To use this tool, it is necessary to indicate which activities make up this project and allocate an estimated time to each project. one of them. In addition, this tool allows to link or not an activity with another so that you can specify which activities can be carried out simultaneously.

The following section describes the activities prior to the start-up of the productive activity. It should be noted that the scope of this project does not include the construction of the industrial building, and that the facilities that have been designed are those of plumbing and refrigeration.

2. Activities

2.1. Building conditioning

As mentioned, the construction of the plot is not within the scope of this project, therefore, to install the machinery chosen for the production lines and the two facilities mentioned, it is necessary a conditioning of the already built industry. The duration assigned to this activity is 1 week.

2.2. Refrigeration installation

The refrigeration installation consists of the evaporator, condenser and the compressor. In addition to the installation of the camera itself in the plant and the discharge, suction and liquid pipes. The duration assigned to this activity is 2 weeks

2.3. Piping installation

The piping installation consists of the assembly of the different calculated pipe sections. The duration assigned to this activity is 2 weeks.

2.4. Production lines installation

Installation of production lines consists of assembly of the corresponding equipment to pepper and asparagus in addition to both autoclaves and an automatic circuit of movement of cages. Taking into account that they are two different production lines, the duration assigned to this activity is 3 weeks.

2.5. Set-up of the machinery

Finally, the set-up of the previously assembled machinery so that the production can start successfully will last 1 week.

3. Gantt Diagram

Then, the graphic representation of the Gantt diagram that summarizes the activities and their durations is presented.

Id	Nombre de tarea	Duración	Comienzo	Fin
1	Acondicionamiento de la planta	1 sem	lun 14/01/19	vie 18/01/19
2	Instalación fontanería	2 sem.	lun 21/01/19	vie 01/02/19
3	Instalación frigorífica	2 sem.	lun 04/02/19	vie 15/02/19
4	Instalación líneas de producción	3 sem.	lun 18/02/19	vie 08/03/19
5	Puesta a punto de la maquinaria	1 sem	lun 11/03/19	vie 15/03/19

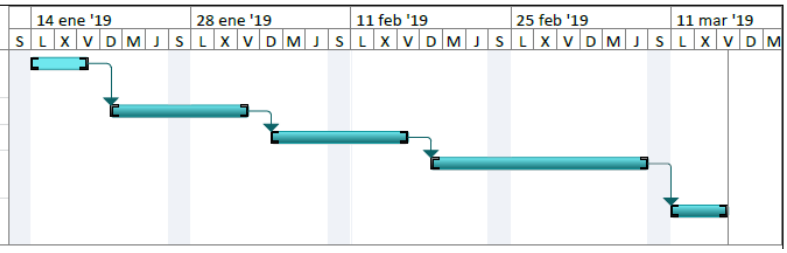

Figura 42: Gantt Diagram

4. Space justification

4.1. Introduction

In order to carry out a distribution in a suitable plant for this industry, the total area of the plot of 5565 m2 has been taken into account, the urbanization of the same has been taken into account since in the southeast facade there is a plot adjoining that prevents access to the industry.

In addition, the different needs that the spaces required were considered. The spaces to be taken into account that require fixed dimensions are the production room, the processed product warehouse, the raw material storage chamber and the services and changing rooms. These spaces require fixed dimensions since it is necessary to be able to store a quantity of raw material and determined product, it is necessary to have sanitary equipment for the whole plant and the equipment has its own measures.

4.2. Production area

First, the production area of the industry consists of the two production lines together with the automatic autoclave system. However, the palletizing and labeling line is arranged in a different room adjacent to the production area.

4.3. Pepper and asparagus

To be able to carry out a correct distribution in the plant, it is necessary to know the space requirements that each machine requires. The measurements have been taken with respect to the complete space occupied by each machine and not to the dimensions of the equipment only. An example is presented.

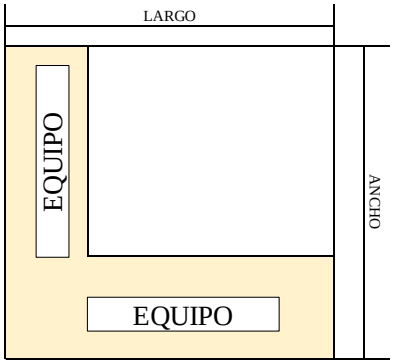

Figura 43: Example of the space justifications measurements

In this case, a table below shows the machines and spaces required in both production lines.

Table 61: Surfaces required

		Length (mm)	Width (mm)	Surface (m^2)
PEPPER	**Sorter machine**	5750	2250	12,94
	Roasting machine	6000	2050	12,30
	Transporting band	4000	2050	8,20
	Disheartened	8000	3500	28,00
	peeling and pips removal	8000	3500	28,00
	Filling	7000	7000	49,00
	Sealing	7000	6000	42,00
		TOTAL		180,44
		TOTAL (majored)		225,55
ASPARAGUS	**Washing and sorting**	6000	500	3,00
	Transporting bands and peeling	7000	7700	53,90
	Blanching	12600	3600	45,36
	Filling	6700	7200	48,24
	Coberture liquid	2620	800	2,10
	Sealing	4200	5200	21,84
		TOTAL		174,44
		TOTAL (majored)		218,05

A coefficient of 1,25 has been applied to take into account the accessibility of staff and distances between equipment and walls.

4.4. Autoclaves

Finally, in the room where both production lines are to be found, autoclaves and their automatic circuit are also available. The data is presented below regarding the area that is required. The same coefficient has been applied as in the previous case.

Table 62: Surfaces required for the autoclaves

	Length (mm)	Width (mm)	Surface (m^2)
Automatized autoclave circuit	18500	17250	319,13
		majored	398,91

Adding the space requirements for the production room, a minimum necessary surface of 842,51 m^2 is obtained.

4.5. Raw material chamber

The chamber of raw material as described in *Annex 9. Refrigeration installation*, has a space needs of 28,16 m^2.

4.6. Finished product storage

In order to calculate the necessary space required for the finished product warehouse, the production of pepper has been taken as a reference since it is higher than that of asparagus. It is estimated that the warehouse should have capacity to store the production of the mita of the season. In the case of pepper, this amounts to 160 t of canned pepper and 75 t of pepper in a glass jar.

Taking into account the measures of the pallets used, and estimating a height of 6 meters of product stored vertically, it is calculated that space is needed for 60 pallets for canned preserves and 32 pallets for canned preserves.

Assuming the warehouse of the products in two rows separated 3 m to allow the passage of personnel and each row with two pallets together, it has been estimated a warehouse of 34,9 m long and 11,1 m wide.

4.7. Restrooms and changing rooms

Lastly, taking into account Royal Decree 486/1997, of 14 April, which establishes minimum safety and health provisions in workplaces, 3 showers and 3 washbasins are estimated for the changing rooms and 3 toilets with 3 washbasins for the bathrooms. In this way, the dimensions of the changing rooms have been estimated at 7 m long and 5 m wide. While the dimensions corresponding to the bathrooms have been estimated at 7 m long by 3,5 m wide.

Therefore, the space needs for the service area and changing rooms, with a corridor that separates the area for the gentlemen from the area for the women, is 182,36 m^2.

4.8. Conclusion

Taking into account the space needs required by the previously mentioned areas, the distribution in the industry floor has been carried out. The engine rooms and boilers have direct access to the outside. The raw material storage chamber has been arranged as close as possible to the engine room, leaving between them a corridor that prevents the transfer of heat between the machinery and the cold room, since it would imply an extra load for it.

The processed product warehouse has been arranged in such a way that there are direct connections with the production room and with the product dispatch area. It has also been estimated a space for the reception of raw materials, packaging and additives, which connects with the raw material storage chamber, with the production line and with the packaging and additives warehouse.

Finally, a space has been established for the reception of personnel and customers, from which the offices and laboratory or the production line can be accessed. The bathroom and changing area is located away from the production area.

PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

Public University of Navarre

SCHOOL OF AGRICULTURAL ENGINEERING

Agri-food & Rural Environment Engineering

ANNEX 11. ECONOMIC STUDY

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

March 2018

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1. Introduction

In this section of the project, the economic-financial evaluation will be carried out and its objective is to quantify the cost of the project monetarily and analyze whether it is economically viable or not.

To carry it out, the payment of the investment will be studied, that is, the amount that the investor must pay to start the investment. The time horizon or useful life of the project will be studied, that is, the period of time that elapses from the beginning of the investment until it stops producing the expected interests

The present cash flow will be studied, that is, the difference between revenues and costs generated in a given year of production. Being the income, the inflows of funds to the company and the costs of the annual disbursements due to the company's own activity.

In addition, the Net Present Value (N.P.V.), which consists of the profit or absolute profitability of the project, consists of subtracting the payment of the investment from the sum of cash flows. The Internal Rate of Return (I.R.R.) will also be used, which provides the relative profitability of the investment and allows, therefore, to compare investments with very different initial disbursements. It is the update rate with which the NPV takes the value zero.

2. Temporal horizon

Taking into account the nature of the project in question and the execution budget of the project amounting to 1601581.01 €, a useful life of 20 years is proposed.

3. Incomes

3.1. Ordinary

In this case, the ordinary income consists of the sale of the product that has been produced. These products being preserved foods that have a shelf life of several years, it has been estimated a sale percentage of 60% of the total production. Revenue is presented in the following table.

Table 63: Ordinary incomes

Product		Units/year	€/Unit	Annual incomes
Pepper	A.O.	520000	3	1560000
	Piquillo	800000	4	3200000
Asparagus	S.A.	186240	6,5	1210560
	White	294400	3,25	956800
			total (€)	6927360
			total (€) 60%	4156416

It is estimated that during the first 3 years the income will be lower than the rest of the years since experience is needed that the company does not have. It is assumed 75% the first 3 years. That is, in the first years 75% of 60% of the total is considered and it is estimated that over the years sales become more homogeneous, ending with the sale of 100% of the finished product. Following the ordinary income, the extraordinary income of the company is presented.

3.2. Extraordinary incomes

Regarding the extraordinary income, the sale of machinery at the end of its useful life is taken into account. A useful life of the machinery of 10 years is estimated, so there will be two extraordinary income. A value of 8% of the initial investment is taken as value for the machinery sold.

Therefore, in year 10, the extraordinary income will represent 140,472.32 €. In the year 20, the extraordinary income from the sale of used machinery, it is estimated a value 10% higher than the previous one due to the increase in the price of the machinery, that is, of 154519,552 €.

4. Expenses

4.1. Ordinary

4.1.1. Investment

Within the ordinary expenses is the payments of the investment that must be made, the cost of this investment amounts to 1601581,01 € as described in the *Documento 5. Measurement and budget*. In order to be able to carry out the investment, a loan is requested from the bank for this amount, which is granted with 10% and must be repaid in 15 years, with an annual amortization fee of € 133465,08 without counting the first 3 years of production Next, a table with loan payments is presented.

Table 64: Investment payment

Years	live capital (€)	Share (€)	interest (€)	Payment (€)
0	1601581,01			
1	1601581,01	0,00	160158,10	160158,10
2	1601581,01	0,00	160158,10	160158,10
3	1601581,01	0,00	160158,10	160158,10
4	1468115,92	133465,08	160158,10	293623,18
5	1334650,84	133465,08	146811,59	280276,68
6	1201185,75	133465,08	133465,08	266930,17
7	1067720,67	133465,08	120118,58	253583,66
8	934255,59	133465,08	106772,07	240237,15
9	800790,50	133465,08	93425,56	226890,64
10	667325,42	133465,08	80079,05	213544,13
11	533860,34	133465,08	66732,54	200197,63
12	400395,25	133465,08	53386,03	186851,12
13	266930,17	133465,08	40039,53	173504,61
14	133465,08	133465,08	26693,02	160158,10
15	0,00	133465,08	13346,51	146811,59

4.1.2. Raw material

In addition, in the ordinary costs of the company, we have the expense in raw material to be able to produce, it is presented in the following table.

Table 65: Raw material expense

Raw material	Price/kg (€)	Annual kg	Total price (€)
Pepper	0,4	470000	188000
Asparagus	3	300000	900000
		total (€)	1088000

4.1.3. Auxiliary raw material

As for the auxiliary material, containers for preserves and cardboard boxes are taken into account. The costs are presented in the following table.

Table 66: Auxiliary raw material expense

	Auxiliary material	Price/Unit (€)	Anual units	Total price (€)
Cardboard boxes dimensions (mm)	427 x 285 x 150	0,6	21700	13020
	300 x 240 x 175	0,6	17160	10296
	350 x 350 x90	0,6	55000	33000
	470 x 470 x 120	0,6	20240	12144
Glass bottles (ml)	314	0,25	650000	162500
	580	0,34	232800	79152
Metal cans (ml)	720	0,25	353280	88320
	425	0,15	1000000	150000
			Total (€)	548432

An expense of € 250000 has been estimated for other types of expenses such as the purchase of additives, micrfilm, necessary auxiliary machinery (scales, thermometers ...). These quantities include elements that can not be specified at this time, such as pallet handling machines or similar machines.

4.1.4. Salaries

Next, a table with the monthly salaries of the personnel that is considered necessary in the company is presented.

Table 67: Salaries expense

Workforce	Number/post	Monthly salary/person	Monthly salary expense (€)	Annual salary expense (€)
Manager	1	4000	4000	48000
Laboratory technicians	4	2000	8000	96000
Commercial	2	2200	4400	52800
Administration	3	1500	4500	54000
Production manager	1	2500	2500	30000
Maintenance	10	1900	19000	228000
Workers	30	1200	36000	108000
	60	1200	72000	180000
Reception	1	1300	1300	15600
			Total (€)	812400

4.2. Extraordinary

Within the extraordinary expenses of the company, the cost of insurance is taken into account, a value of € 50000/year is estimated. In addition, as mentioned in the scope of the project, the electrical installation is not projected, so it is estimated a value of € 40000/year.

It is estimated an office expense value of € 5,000/year and a laboratory cost of € 8,000/year. Another aspect to take into account within the extraordinary costs are the spare parts that the machines may need and the maintenance of the same. The replacement of the machinery is estimated at 10% of the initial investment for the machines and maintenance 15% of the initial investment. It has been estimated a telephone expense by the company of € 10,000.

Finally, the renewal of the machines should be taken into account when their useful life ends, at ten years, this cost is estimated 10% higher than the initial investment allocated to the machine due to the increase in the price of the equipment.

5. Cash flow and profitability indexes

Table 68: Cash flows

Years	Ordinary incomes (€)	Extraordinary incomes (€)	Ordinary expenses (€)	Extraordinary expenses (€)	Investment payment (€)	Cash flows (€)
0					1601581,01	-1601581,006
1	3117312		2448832	639175,0983	153069,98	-123765,08
2	3117312		2448832	639175,0983	153069,98	-123765,08
3	3117312		2448832	639175,0983	153069,98	-123765,08
4	3117312		2448832	639175,0983	280628,30	-251323,40
5	4156416		2448832	639175,0983	267872,47	800536,43
6	4156416		2448832	639175,0983	255116,64	813292,27
7	4156416		2448832	639175,0983	242360,80	826048,10
8	4156416		2448832	639175,0983	229604,97	838803,93
9	5195520		2448832	639175,0983	216849,14	1890663,76
10	5195520	140472,32	2448832	1854345,531	204093,31	828721,48
11	5195520		2448832	639175,0983	191337,48	1916175,43
12	5195520		2448832	639175,0983	178581,64	1928931,26
13	5888256		2448832	639175,0983	165825,81	2634423,09
14	5888256		2448832	639175,0983	153069,98	2647178,92
15	5888256		2448832	639175,0983	140314,15	2659934,75
16	5888256		2448832	639175,0983		2800248,90
17	6927360		2448832	639175,0983		3839352,90
18	6927360		2448832	639175,0983		3839352,90
19	6927360		2448832	639175,0983		3839352,90
20	6927360	154519,552	2448832	629175,0983		4003872,45

During the 20 years of the project's horizon, cash flows will be obtained that are presented in the table, in addition to the financial payments of the loan. Next, the profitability indexes are presented.

5.1. Net present value (N.P.V)

The Net Present Value (N.P.V) is an economic profitability index that refers to the total profit or absolute profitability of the project. It is used to evaluate the return on investment and consists of subtracting the payment of the initial investment from the sum of cash flows. The initial investment in this case is 1601581,01 €.

$$VAN = -I_0 + \sum_{t=1}^{n} \frac{Flujo\ Anual}{(1 + Tasa)^t}$$

Figura 40: Formula for calculating the NPV

The annual flow is the cash flow obtained, the chosen update rate is 10% and the Io is the initial investment necessary to carry out the project. Using this formula you get a value of NPV of 6,797,552.10 €. Taking this profitability index into account, the viable project is considered as the value is greater than zero, if it were a value of V.A.N. negative would generate losses.

5.2. Internal Rate of Return

The Internal Rate of Return (I.R.R.) is used to obtain the relative return of the investment. It is also defined as the value that makes the NPV be zero, in this case the value of the IRR It is 26%.

5.3. Period of payback

Cash flows are taken into account and the following formula has been used to calculate the recovery period.

A = Last period with negative accumulated flow

B = Absolute value of the last negative accumulated flow

C = Cash flow value in the next period

Payback period = A + (B/C)

In this case, the value of Payback is 6,75 years, that is, it will be achieved in 7 years of production.

PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

Public University of Navarre

SCHOOL OF AGRICULTURAL ENGINEERING

Agri-food & Rural Environment Engineering

DOCUMENT 3. DRAWINGS

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

March 2018

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MARKED AREA: PLOT LOCATION IN LODOSA
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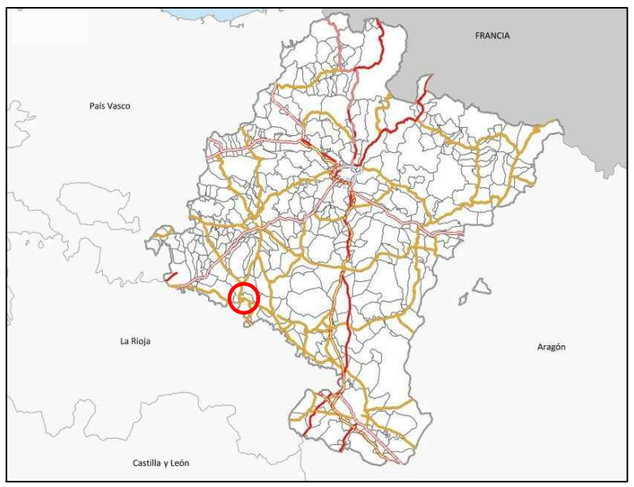

MARKED AREA: LODOSA, NAVARRA
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CHOSEN PLOT
SCALE E2 1:2000

CHOSEN PLOT, VIEW WITH RELIEF
SCALE E1 1:4000

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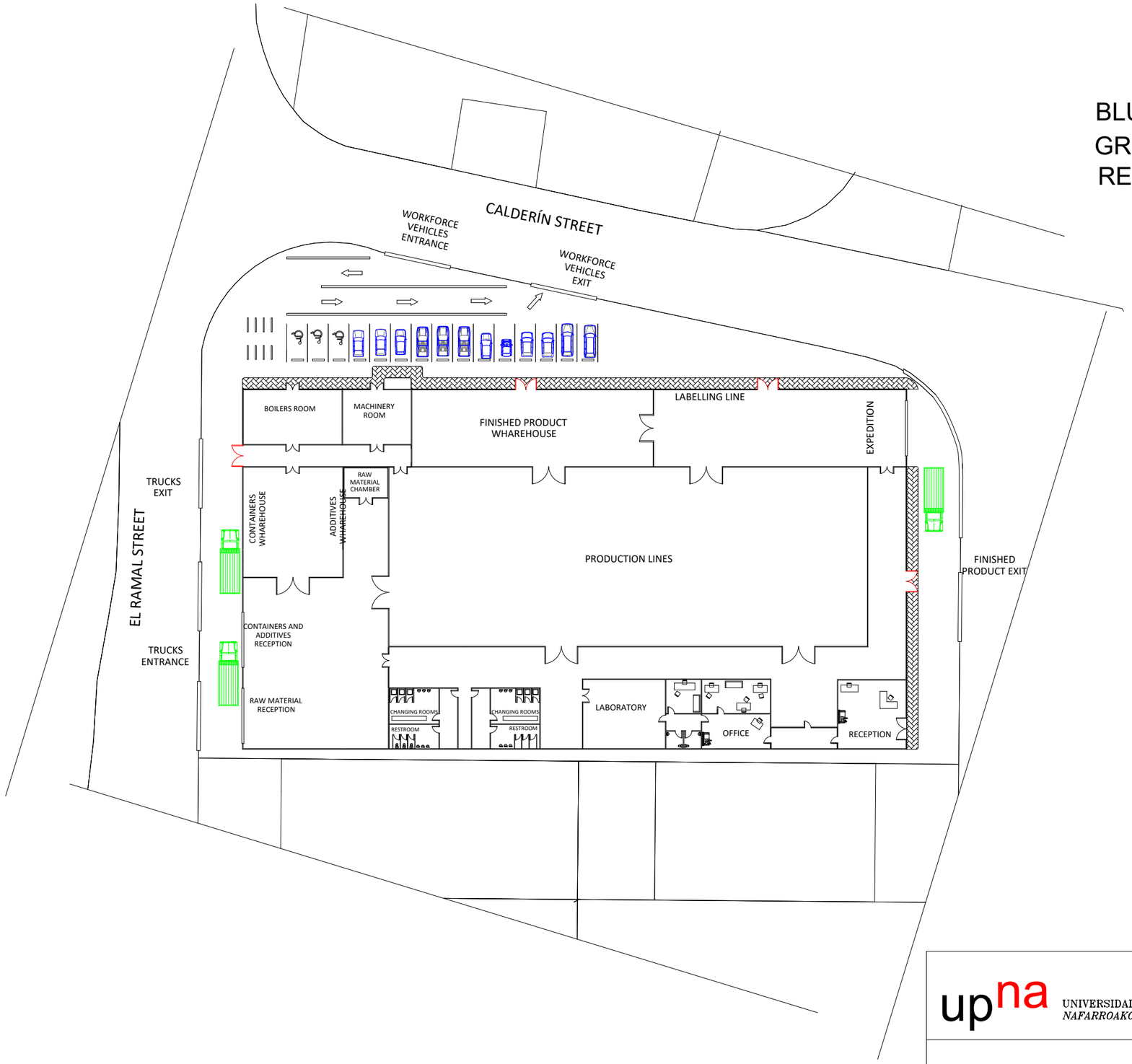
BLUE : WORKFORCE VEHICLES
GREEN : RECEPTION AND EXPEDITION TRUCKS
RED : EMERGENCY EXITS



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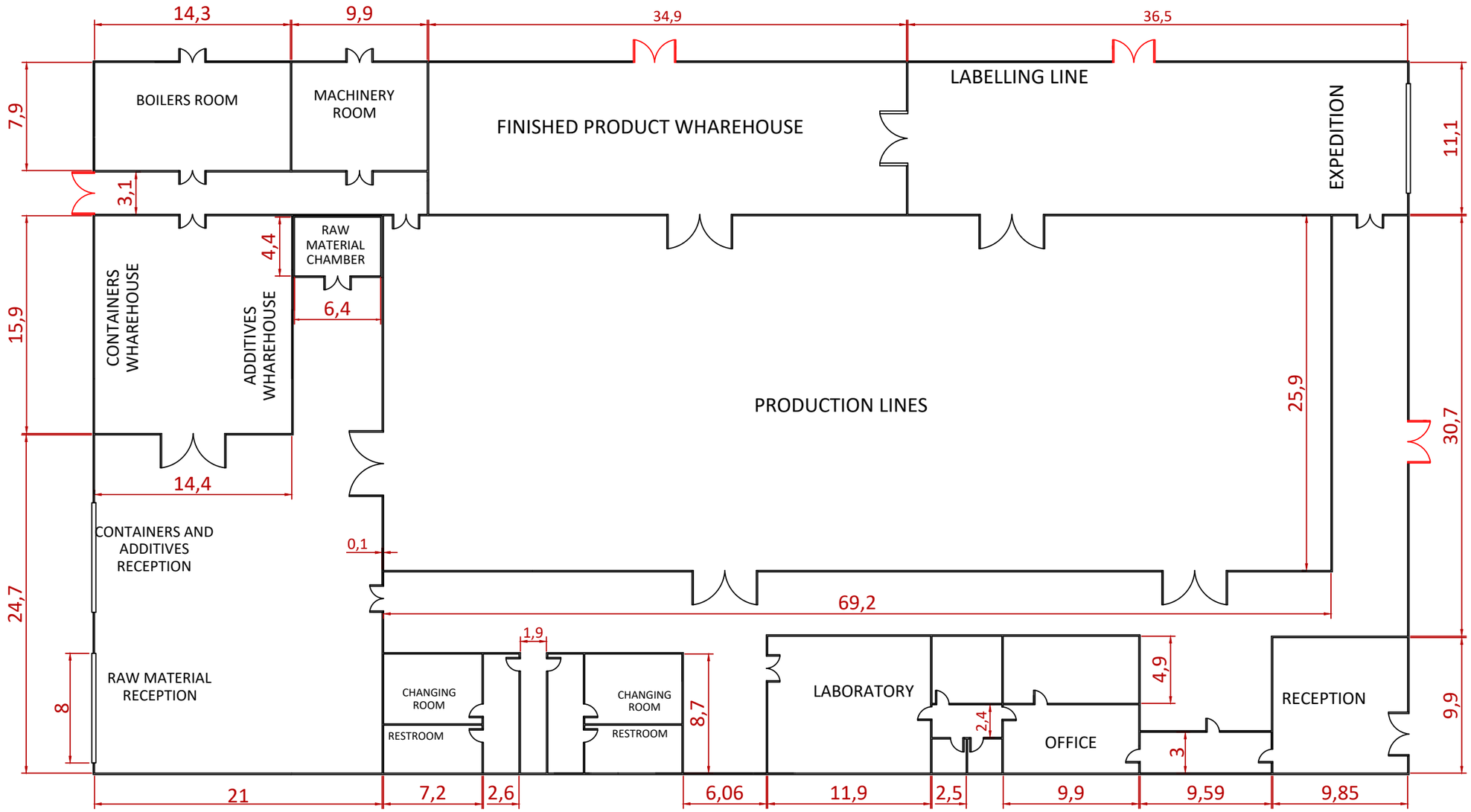

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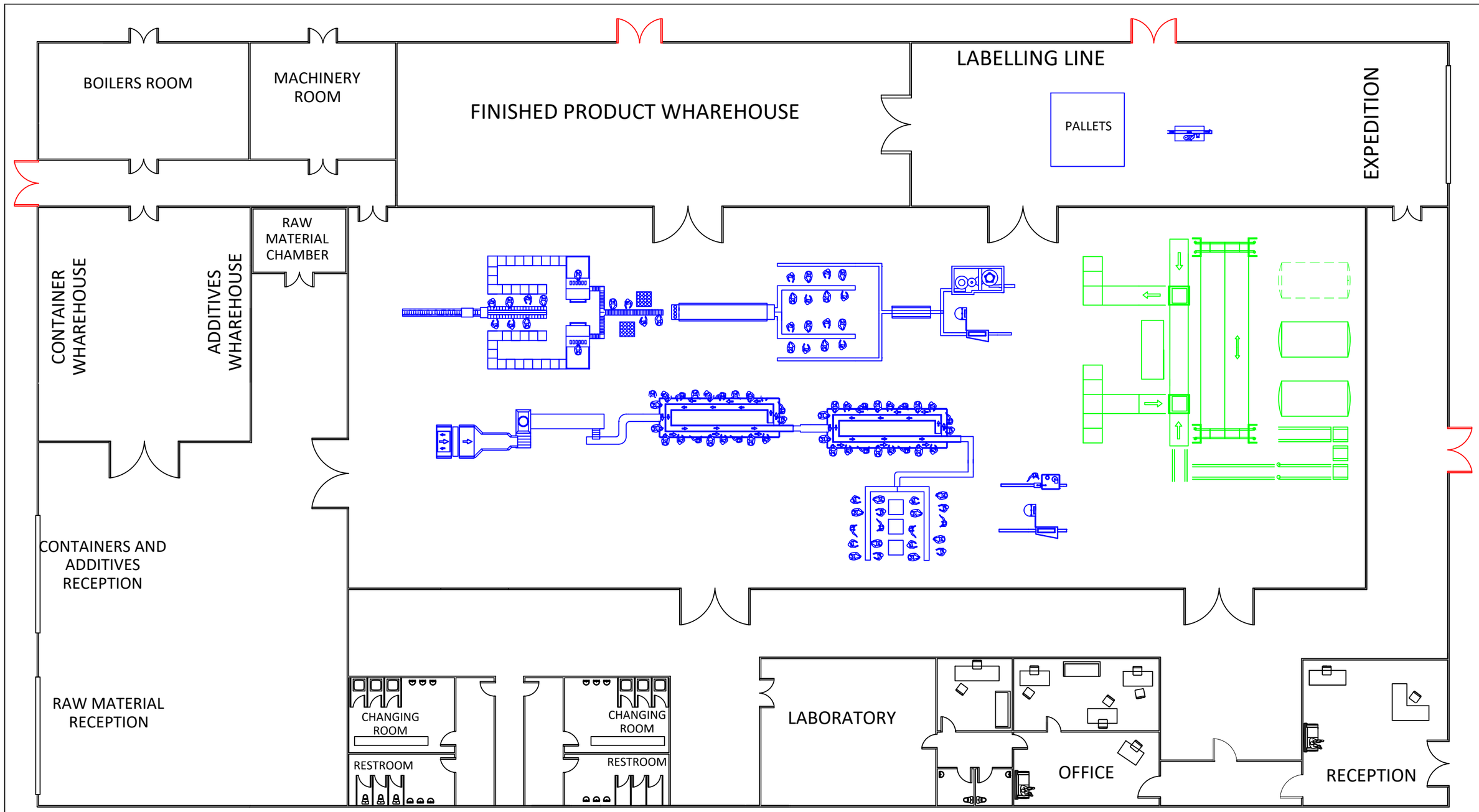

BLUE: PRODUCTION LINES
GREEN: AUTOMATIC SYSTEM FOR THE AUTOCLAVES
RED: EMERGENCY EXITS

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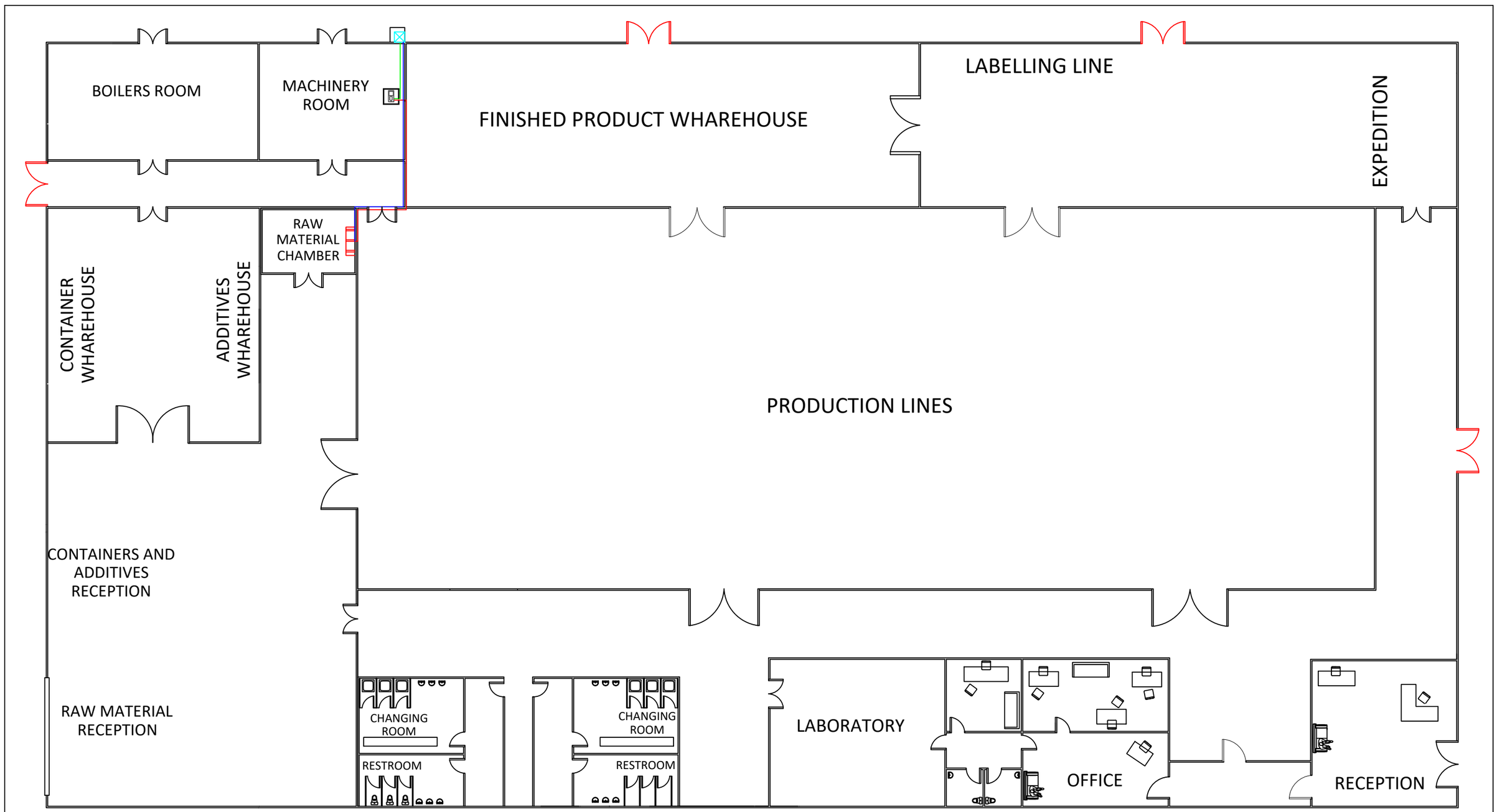

EVAPORATOR

COMPRESSOR

CONDENSER

ASPIRATION PIPE — Material: Copper (standard bars) Ø= 1,65"

DISCHARGE PIPE — Material: Copper (standard bars) Ø= 0,8"

LIQUID PIPE — Material:Copper (standard rolls) Ø= 1"

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TITLE: PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY		AUTHOR: JOSE JAVIER NUÑEZ IÑARRA		
		SIGNATURE		
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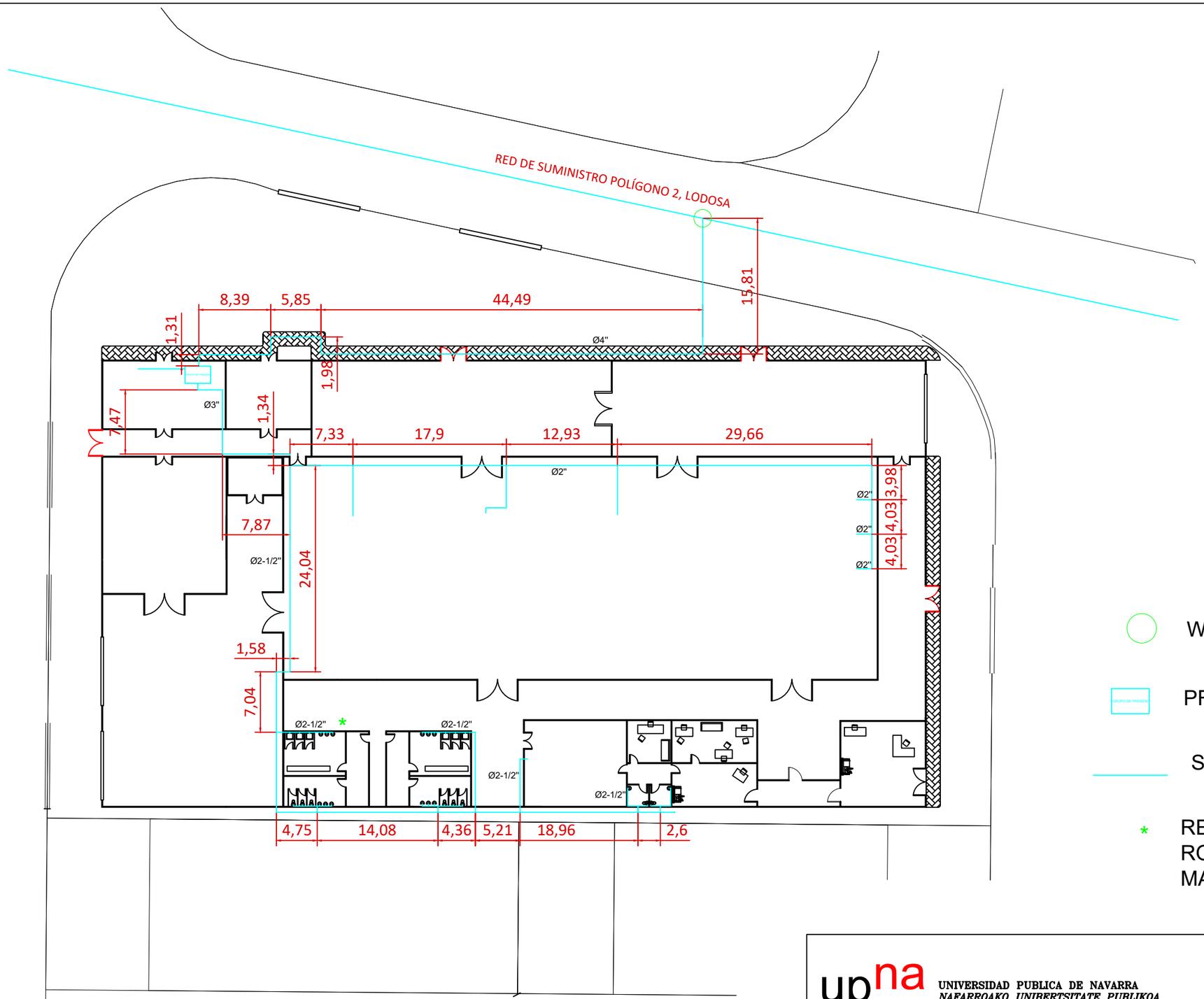

WATER SUPPLY POINT

PRESSURE GROUP

STAINLESS STEEL PIPES ASME 31.1

* RESTROOMS AND CHANGING ROOMS PIPES WITHOUT DIAMETER MARKED, Ø2-1/2"

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TITLE: PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY		AUTHOR: JOSE JAVIER NUÑEZ IÑARRA		
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PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

Public University of Navarre

SCHOOL OF AGRICULTURAL ENGINEERING

Agri-food & Rural Environment Engineering

DOCUMENT 4. SPECIFICATION SHEET

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

March 2018

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1. Introduction

This document will describe the different conditions that must be met in this company in general and in particular in the preparation of the selected products, since part of the production is under an appellation of origin and a specific appellation. These requirements are available for all vegetable preservation companies.

2. Requirements with reference to the industry

2.1. General hygienic-sanitary requirements

2.1.1. Manufacturing

The manufacturing and storage rooms and their annexes, in any case, must be suitable for the use for which they are intended, with adequate location, wide and easy access, located at a convenient distance from any cause of contamination or unhealthiness and severely separated from dwellings. or premises where you spend the night or make your meals from anyone.

All the premises, zones and spaces destined to the elaboration, packaging and in general, to the manipulation of raw materials, intermediate or final products, will be adequately isolated from any others outside their specific tasks.

Regarding the construction or repair, suitable materials will be used and in no case, capable of causing poisonings or contamination. The pavements will be practically impermeable, washable and fireproof, providing them with the precise drainage systems.

The walls and ceilings should be constructed with materials that allow their conservation in suitable cleaning conditions. In addition, drains should have hydraulic closures when they discharge to contaminated water collectors and will be protected with grids or perforated plates of resistant material.

All companies must have a laboratory with the personnel and the necessary methods to perform the controls of raw materials and finished products that require the correct manufacture and compliance with the regulations. Services external to the factory may be used for those analyzes that require certain techniques and special devices.

As for the verification of raw materials, packaging and lots of manufacture and, in general, as many tests require a guarantee of correct manufacture, will be made according to the methods to be published by Resolution of the “Dirección General competente del Ministerio de Sanidad y Seguridad Social“.

2.1.2. Environmental conditions

Ventilation and lighting, natural or artificial, will be the regulations and, in any case, appropriate to the capacity and volume of the premises, according to the purpose for which it is intended. Running water will be available at all times, in sufficient quantity for the cleaning and washing of facilities and industrial elements, as well as for the cleaning of the personnel. They will have to have hygienic services and changing rooms in number and characteristics adapted to what they foresee, for each case, the competent authorities.

All the premises must be constantly kept in a state of cleanliness and cleanliness, adequate to their function, which must be carried out by the most appropriate methods so as not to raise dust or produce alterations or contaminations. They will have services, defenses and tools and adequate facilities in their construction or site to ensure the conservation of their products in the best conditions of hygiene and cleanliness and non-contamination by proximity or contact with any

kind of waste or waste water, dirt and foreign matter, as well as the presence of insects, rodents, birds and other animals.

The temperatures, relative humidity and circulation of the air in the premises, will be convenient to avoid that the products suffer alterations or changes in their characteristics. These premises will be protected against the direct action of sunlight, when it is harmful to the products.

The storage will be carried out in such a way as to allow the rotation of the stocks and periodic removals, depending on the storage time and storage conditions required by each product.

Any other technical, sanitary, hygienic and labor conditions established or established, in their respective competencies by the "Organismos de Administración Pública".

2.2. Industrial requirements

2.2.1. Reception area

The unloading area will be specially protected so that there is no contamination in case of adverse environmental conditions, such as wind, rain, vehicle gases, etc. Air currents should be avoided from outside to inside.

The size must be appropriate to the raw material to be received and must allow the first cleaning work of the same raw material if required. The area will be prepared to maintain adequate temperatures according to the nature of the product. If there is product manipulation in this area by the personnel, there will be a hand-operated washbasin.

2.2.2. Raw materials warehouses, processing aids and containers or packaging

There should be different storage cold storage chambers for:

- Raw material
- Semi-finished product
- Finished product

In addition, there must be separate stores for non-food products such as:

- Additives and process aids
- Containers and packaging

The disposition of the storage of the products will respect minimum distances of security between walls and the floors, that allow to carry out the tasks of cleaning and disinfection. In the stores, the temperatures and humidity necessary for each product must be maintained. The storage will accomplish the following general conditions:

- Distribution of food in piles or lots that keep the proper distance between them, and with walls, floors and ceilings.
- Use of surface and height spaces and storage system suitable for movement, reception, handling and dispatch.
- Rotation of stocks and periodic removals depending on the storage time and storage conditions required by each product.
- Periodical recognition and inspection of the conditions of the premises and the state of the food.
- Withdrawal of deteriorated, infested or contaminated foods, as well as those whose packages appear broken. It will proceed, according to the cases, to its disablement or to its destiny to other uses that are not the human consumption. With regard to the premises, appropriate measures will be taken to avoid further contamination.
- Convenient air circulation.

- Isolation of articles that give off odors from those others that by their nature can absorb them.

2.2.3. Areas of handling, manufacturing and packaging

In general, the production lines will be distributed in such a way as to avoid crossings between raw materials, semi-finished product and finished product.

If there is more than one manufacturing line, these will be separated so that crossings between products are not allowed. Product setbacks will also be avoided in the production lines.

The surfaces of equipment and materials intended to be in contact with food should be easy to clean and disinfect. The materials of these should be smooth, washable, resistant to corrosion and non-toxic. If so required, there will be a suitable area or installation for cleaning, disinfecting and storing equipment and work tools.

The containers, containers, machines and pipes intended to be in contact with the finished products or with their raw materials or with the intermediate products, will be made of materials that do not alter the characteristics of their content or of themselves. They must also be unalterable against the products used in their cleaning.

Water must be available at all times for sanitary water that is tolerable from the physical-chemical and microbiologically portable pressure point, cold or hot, in sufficient quantity for the preparation, handling and preparation of products, as well as for the cleaning of personnel in plant. The washing of utensils and installations may be carried out with water of other characteristics, but always drinkable from the microbiological point of view.

Washing area

The washing / cleaning area of raw material will be physically separated from the rest of the handling in order to avoid crossings from the dirty area to the clean one. If the typology of the company requires it, the activities will be carried out in different rooms.

If the typology of the company requires it, the facilities destined to the washing of food products should be separated from the facilities used to wash their hands.

Waste containers, peeling, etc., if any, should be well preserved, provided with closure, be easy to clean and disinfect and be removed from the rooms where there is food as quickly as possible, preventing their accumulation.

If there is product handling by personnel in this area, there will be a non-manual hand wash.

Area of handling, packaging and closure

The lines prior to packaging will be covered or placed in an isolated place in order to protect them from environmental contamination.

The container waste containers or nonconforming product from the line, if any, will be well preserved, provided with closure, easy to clean and disinfect and remove from the rooms where there is food as quickly as possible, preventing their accumulation.

Thermal treatment area

A steam extraction system must be installed to avoid the presence of moisture and condensation. The systems will be equipped with thermometers and graphic systems for the control of temperature and pressure.

2.3. General requirements related to the workforce

The personal hygiene of all the employees will be extreme and will have to fulfill the general obligations, sanitary state control and others that the Spanish Food Code specifies in its articles 2.08.04, 2.08.05 and 2.08.06.

The personnel that perform their function in the areas of preparation and packaging of the products must wear appropriate clothes with the necessary neatness and hygiene. It is prohibited to eat, smoke and chew gum or tobacco in manufacturing premises.

In all the factories the personnel in charge of the sterilization and closing processes will accredit their competence in these matters.

2.4. Requirements related to the raw material, ingredients and finished products

In general, the raw materials used in the preparation of canned products and semi-canned will be mainly fruits, cereals, vegetables, legumes, tubers, and edible fungi, as well as their derivatives.

In addition, edible water, fats and oils, wine, spirits and liqueurs, juices, sugars, salt and other condiments and spices related in Chapter XXIV of the Spanish Food Code are also considered raw materials.

Depending on the type of preserved and semi-preserved, only the aromatic agent and additives authorized by Resolution of the competent General Directorate of the Ministry of Health and Social Security may be used.

All ingredients must comply with the purity standards that are required for these products in the Spanish Food Code and specific regulations.

Canned products and semi-canned that are available for consumption must not contain more heavy metal waste than the limits indicated below:

- Plumb: 1 p.p.m
- Copper
    - General canned products: 10 ppm
    - Canned tomato and peas: 30 ppm
- Arsenic: 1 ppm
- Tin
    - General canned products: 250 ppm
    - Canned asparagus: 350 ppm

2.5. Requirements regarding mandatory, permitted and prohibited manipulations

2.5.1. Mandatory

Regarding the prescriptive manipulations, that is to say that they must be fulfilled, they are the washing or cleaning of the raw materials, the necessary operations for the obtaining and conservation adapted to the type of preserved in question.

2.5.2. Permitted

As regards the manipulations that are considered allowed, are the treatment of the products with gaseous sulfur dioxide or in solution. Also, the peeling of raw materials by treatment with

chemical substances such as acids, or other substances authorized by the competent General "Dirección General competente of the Ministerio de Seguridad y Salud Social". The treatment of the fruit destined to the pasificación with authorized substances for that end and the operations directed to improve the technical and hygienic-sanitary conditions of the final product are the last two manipulations that are considered allowed.

2.5.3. Forbidden

Finally, below, the manipulations that are considered prohibited are mentioned. The treatment of semi-canned and canned vegetables by radioactive agents. The elaboration of semi-canned and canned vegetables in facilities or industries that do not have the regulatory authorizations. In addition to the re-freezing of semi-canned products and canned vegetables that would have lost this condition. It is also prohibited to store in unsuitable conditions, the use of ingredients and non-authorized additives. The distribution and sale of canned vegetables sterilized by heat in non-hermetic containers, bulging, fractured or with signs of having been resolved or with external oxidation accentuated. To finish, it is forbidden the sale to the public of semi-canned and canned vegtables whose containers lack regulatory identification.

2.6. Requirements related with the filling, labelling and lettering

2.6.1. Filling

The packaging materials may be tinplate, glass, aluminum or macromolecular materials, properly coated cardboard and other materials authorized by the competent General Directorate of the Ministry of Health and Social Security. The materials and packaging must comply with the requirements set forth in chapter IV of the Spanish Food Code, the specific regulations and standardization of size, formats required by the Ministry of Industry and Energy.

It is prohibited to sell canned vegetables in recovered containers, with the exception of glass and industrial containers of large capacity whose material or internal coating and closure system allows cleaning and sterilization.

2.6.2. Labelling and lettering

The labeling and the modalities of carrying it out should not be of such a nature as to mislead the buyer, especially about:

- The characteristics of a food product and, in particular, its nature, identity, qualities, composition, quantity, duration, origin or provenance, and way of manufacturing or obtaining it.
- Attribute to the food product effects or properties that it does not have.
- Suggest that the food product has particular characteristics, when all similar products have these same characteristics.
- To attribute to a food product preventive, therapeutic or curative properties of a human disease, or mentioning said properties, without prejudice to the provisions applicable to mineral waters and food products intended for a special diet.

Mandatory information of the labelling

The information that must appear compulsory in the labeling of food products is:

Product sale denomination

The denomination of sale of a food product will be the denomination foreseen for this product in the provisions of the European Community that are applicable to it. In the absence of provisions of the European Community, the name of sale will be the name provided for by the laws, regulations or administrative provisions that are applicable in Spain.

Due to this, it will be constituted by the name consecrated by the use in Spain, or by a description of the food product and its use, if necessary, sufficiently precise to allow the buyer to know its real nature and distinguish it from the products with the that could be confused.

The sales denomination can not be replaced by a trademark or factory or a fancy name.

The sales denomination shall include or be accompanied by an indication of the physical state in which the food product is located or of the specific treatment to which it has been subjected (such as powder, freeze-dried, frozen, concentrated, smoked), in case the omission of such indication could lead to confusion for the buyer. All food products that have been treated with ionizing radiation must bear one of the following mentions "irradiated" or "treated with ionizing radiation".

Ingredients list

The list of ingredients must be preceded by the title "ingredients" or an appropriate mention that includes that word and that does not lead to error. The list of ingredients will be constituted by the mention of all the ingredients in descending order of their weights at the time they are incorporated during the manufacturing process of the product. However, the water that is added as an ingredient in a food product will be indicated in the list according to its weight in the finished product. The ingredients that constitute less than two percent of the finished product may be listed in a different order, following the other ingredients.

Quantity and category of ingredients

The quantity of an ingredient or category of ingredients used in the manufacture or preparation of a food product shall be indicated, provided that:

- The ingredient or category of ingredients in question is included in the sales denomination or is generally associated with the sales denomination by the consumer.
- In the labeling the ingredient or the category of ingredients in question is highlighted by means of words, images or graphic representation.
- When the ingredient or category of ingredients in question is essential to define a food product and to distinguish it from products with which it could be confused because of its name or appearance.

Net quantity for packaged products

The net quantity of the packaged food products shall be expressed:

- In units of volume for liquid products.
- In units of mass for others.
- It will be used, depending on the case, the liter (l or L), the centiliter (cl), the milliliter (ml) or the kilogram (kg) or the gram (g).

The technical-sanitary regulations or specific rules may establish exceptions to this rule for some food products. The technical-sanitary regulations or specific rules may establish other indications of quantity for certain food products that are classified in categories by quantity. When establishing the indication of a quantity type, such as: nominal amount, minimum quantity, average quantity, this amount will be, for the purposes of this General Standard, the net quantity.

When a container is constituted by two or more individual packages containing the same quantity of the same product, the net quantity shall be indicated mentioning the net quantity contained in each individual container and the total number of packages. However, these indications will not be obligatory when the total number of individual packages can be clearly seen and easily counted from the outside, and when at least one indication of the net quantity contained in each individual package can be clearly seen from the outside.

When a container is constituted by two or more individual packages that are not considered sales units, the net quantity will be indicated mentioning the total net quantity and the total number of individual packages. The technical-sanitary regulations or specific rules may provide, for certain food products, that the total number of individual packages is not indicated.

In the case of foodstuffs that are sold normally by units, the indication of the net quantity will not be mandatory, as long as the number of units can be clearly seen and easily counted from the outside or, failing that, indicated on the labelling.

When a solid food product is presented in a covering liquid, the net drained mass of said food product will also be indicated on the labeling. Covering liquid means the products mentioned below, if any, mixed together and also when presented in a frozen or quick-frozen state, provided that the liquid is only accessory with respect to the essential elements of the preparation and, consequently, not determinant for the purchase: water, aqueous solutions of salts, brines, aqueous solutions of food acids, vinegar, aqueous solutions of sugars, aqueous solutions of other substances or sweetening materials and of fruit or vegetable juice in the case of fruits and vegetables.

The indication of the net quantity will not be mandatory for food products:

- That they are subject to considerable losses of their volume or mass and sold by units or are weighed before the buyer.
- Whose net amount is less than 5 grams or 5 milliliters. This exception will not apply in the case of spices and aromatic plants.

The technical-sanitary regulations or specific rules may establish exceptionally and without detriment to the buyer's information, thresholds greater than 5 grams or 5 milliliters.

Minimal duration or expiration date

In the labeling of all food products, the date of minimum duration or, where appropriate, the expiration date will appear. The date of minimum duration will be expressed by means of the legends:

- "Consume preferably before ..." when the date includes the indication of the day.
- "Consume preferably before the end of ...", in other cases.

The indications provided in the previous section, will be accompanied or dated, or the indication of the place where it appears on the label. In some cases, if necessary, these indications will be completed with the reference to the conservation conditions that must be observed to ensure the indicated duration.

The date will consist of the clear indication and in order of the day, month and year. However, in the case of food products whose duration is less than three months it will be sufficient to indicate the day and the month. In foods whose duration is greater than three months, but not exceeding eighteen months, it will suffice to indicate the month and year or in foods whose duration is greater than eighteen months, it is sufficient to indicate the year.

The lot

The indication of the batch will be made in accordance with the provisions of Royal Decree 1808/1991, of December 13, which regulates the mentions or marks that allow identifying the batch to which a food product belongs.

Origin

In the products coming from the Member States of the European Union, the place of origin or provenance should be indicated only in cases where their omission could mislead the consumer about the origin or real origin of the food product.

Products originating in countries outside the European Union must indicate the place of origin or provenance, without prejudice to the provisions of international Treaties or Conventions on the subject that are applicable in Spain.

3. Requirements related with the production

In this industry two products covered under one appellation of origin and one specific appellation are going to be produced, whose requirements are described below.

3.1. Pimiento del Piquillo de Lodosa requirements

3.1.1. Production

The area of pepper production covered by the Appellation of Origin "Pimiento del Piquillo de Lodosa" is constituted by the lands located in Navarra that the Regulatory Council considers suitable for the production of the piquillo pepper with the necessary quality.

In the event that the owner of the land is in disagreement with the Resolution of the Regulatory Council may appeal to the competent body of the Autonomous Community of Navarra which will resolve previous technical reports it deems necessary.

The production area will be composed of the following municipalities: Lodosa, Andosilla, Azagra, Cárcar, Lerín, Mendavia, San Adrián and Sartaguda. The Regulatory Board has the capacity to propose an expansion in the production areas.

The pepper that is protected by the Appellation of Origin "Pimiento del Piquillo de Lodosa" is only the pepper of the piquillo variety. Lodosa Piquillo pepper is a selection made in Lodosa of a sweet pepper that is characterized morphologically as red, of short length; medium diameter; small fruit weight; number of lobes 2 or 3; shape of the fruit, triangular; acute apex; bearing of the fruit, hanging.

Cultivation practices will be the traditional ones that tend to achieve the best qualities. In addition, innovations aimed at increasing production will be allowed, if they do not have the detriment of quality.

The Regulatory Council of appellations of origin may give campaign rules and regulate the plantation regime. In addition, it will control the productions by parcels, for which it may require the physical or legal persons integrated in the Appellation of Origin to submit their sales contracts, buyers to whom the product is delivered, etc., in order to be able to differentiate the products received from those not covered.

3.1.2. Elaboration

The piquillo pepper that is going to be protected by the Appellation of Origin must be selected carefully before submitting it to the elaboration process, eliminating the defective, damaged or broken fruits.

The pepper that in the opinion of the Council does not have the necessary qualitative characteristics can not be covered by the Appellation of Origin and will be disqualified.

Canned peppers of Piquillo de Lodosa must comply with the norms established by the legislation in force for the elaboration and sale of canned vegetables, as well as the corresponding specific norms.

The Appellation of Origin will cover only the whole piquillo canned peppers, of extra and first commercial categories. The containers must comply with current regulations on their characteristics and formats.

The Regulatory Council will be able to determine the formats and types that are allowed for canned products under the Appellation of Origin.

The preparation of Lodosa piquillo pepper should start with roasting by direct flame action. For these purposes, the Regulatory Council may prohibit the use of fuels that may impair the quality of the product. The disheartened, peeled and the elimination of the seeds will be done manually and artisan without at any time the fruits are submerged or washed with water or chemical solutions. The liquid of government that is added to the packaging must not exceed 3 percent of the net content of the container.

3.1.3. Registration

The Regulatory Council will carry out records of plantations and processors. The petitions will be addressed to the Regulatory Council, accompanying the data, documents and vouchers that in each case are required by the provisions and regulations in force, in the forms that the Regulatory Council disposes.

The Regulatory Council will deny the registrations that do not conform to the precepts of the regulations of the appellation of origin in question or to the agreements adopted by the Council on complementary conditions that pepper plantations and industries must meet.

The inscription in these registers does not exempt the interested from the obligation to register in those registries that are established, but with a general character.

In the register of plantations, all parcels located in the production area wishing to benefit from the Appellation of Origin will be registered annually, prior to the first of April.

The registration of the plantation register must include the name of the owner and; where appropriate, tenant or owner of the farm and the site, municipal area in which it is located, polygon and cadastral parcels, area and how many data are necessary for its perfect classification and location.

In the register of processors will register all those who, located in the production area, are dedicated to the transformation and / or sale on the domestic market or outside of peppers protected by the Designation of Origin.

The registration of the processors register will include the name of the company, location and area of location, handling capacity, facilities, marketing system and how much data is necessary for the perfect identification and cataloging of the company. In the event that the company does not own the premises, this circumstance will be indicated indicating the name of the owner.

3.1.4. Rights and obligations

Only natural or legal persons whose plantations are registered in the corresponding registry may produce pepper that is to be protected under the appellation of origin. Only the Designation of Origin "Pimiento del Piquillo de Lodosa" can be applied to the piquillo peppers from registered plantations that are elaborated according to the norms demanded by this regulation and that meet the qualitative, technical and organoleptic conditions that should characterize them.

The right to use the Appellation of Origin in advertising, advertising, documentation, or labels is exclusive of the signatures registered in the Council's records. By the mere fact of having registered in the corresponding registers, natural or legal persons are obliged to comply with

the regulations imposed by the specifications of the appellation of origin and the agreements established by the Board.

In the lands occupied by the plantations registered in the plantation registry and in their annexed constructions, they may not enter or have stock of piquillo peppers from plots without the right to the denomination.

In the production facilities registered in the registers, the introduction, handling, processing, storage and marketing of piquillo peppers in fresh or packaged from areas, localities or plantations not included in the Designation of Origin will not be allowed.

Firms that have registered facilities may only have their piquillo peppers stored in the premises that have been declared in the registration. The signatures registered in the corresponding registries of the Council will be able to use, previous authorization of the Council, the commercial names that have registered like of their property or authorized by their proprietors. In order for such authorization to take place, they must request it from the Regulatory Board with the vouchers that this requires, expressly stating that it is responsible for everything related to the use of said name in canned products protected by the Appellation.

The labeling of the containers must include the name of the Appellation of Origin, in addition to the data that are generally determined in the applicable legislation.

Before putting them into circulation, the labels must be authorized by the Council, for the purposes that are related in the specifications of the appellation of origin. The approval of those labels that for any reason may give rise to confusion for consumers will be denied. Also, the authorization of a previously granted one may be annulled, when the circumstances of the firm that owns it have changed, after hearing the signature of the interested party.

Whatever the packaging, it will be provided with a numbered label or counter-label provided by the Regulatory Council, which must be placed before the products are shipped. The regulatory Council will establish the appropriate means with reference to the traffic of containers without label.

If said sale is made to a registered manufacturer, it will be mandatory to accompany the merchandise with the counter-labels that correspond to the vendor manufacturer.

If the sale is made to a manufacturer not covered by the name, the Regulatory Council will notify the seller if it should return the corresponding counter-labels to the Council or is authorized to use it in other items for which it has not yet been issued. has provided counter-labels.

The Regulatory Council shall adopt and register an emblem or logo as a symbol of the Specific Appellation. Likewise, the Regulatory Board may make it compulsory that, outside the facilities inscribed and in a prominent place, there be a plaque that refers to this condition.

The Regulatory Council will monitor in each campaign the quantities of pepper covered by the Appellation issued by each firm registered in the corresponding records, according to the quantities of piquillo peppers from registered plantations, own or foreign and according to stocks and / or acquisitions of asparagus to other registered firms.

Packages of packaged pepper, which for any reason have defects, sensitive alterations or that in handling have broken the conditions required by the specific specifications will be disqualified and this will lead to the loss of the appellation of origin.

3.2. Espárrago de Navarra requirements

As general provisions of the specifications of the designation of origin of Espárrago de Navarra, comment that it is prohibited to use other names, brands, terms, expressions and signs,

which by their phonetic or graphic similarity with the protected may induce confusion with those that are the object of the specifications of the DO in question. Even in the case that they are preceded by the expressions "type", "taste", "elaborated in", "manipulated in", "manufactured in", or other analogues.

In addition, the work of defending the specific appellation, the application of its specifications, the monitoring of compliance, as well as the rest of activities related to the quality of the protected asparagus, are entrusted to the Regulatory Council of the Specific Appellation, to the competent bodies of the Autonomous Communities of Aragon and La Rioja and the Regional Community of Navarra and to the General Directorate of Food Policy of the (MAPAMA) Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente.

3.2.1. Production

The zone of production of asparagus covered by the Specific Designation of Origin "Espárrago de Navarra" is constituted by the lands located in Navarra, Aragón, and La Rioja that in Regulatory Council is considered apt for the production of asparagus with the necessary quality.

The classification of the lands for the purpose of their inclusion in the production area will be carried out by the Regulatory Council, which must be delimited in the plans of the plantation registry as it is drawn up. The Regulatory Council may propose to the Ministry of Agriculture and Fisheries, Food and Environment the extension of the production area to other locations.

Asparagus protected by the specific designation of origin "Espárrago de Navarra" will have tender and fresh shoots and will be Asparagus, officinalis, L, whether white, purple or green from previous varieties, can be marketed fresh, frozen or in retains, provided that they meet the requirements required by legislation and by the Regulatory Council.

The Regulatory Council may propose to MAPAMA that new varieties be authorized that, after trials and suitable experiences, prove that they produce quality asparagus, which can be assimilated to the traditional asparagus of the area.

The cultivation practices will be the traditional ones that tend to achieve the best qualities. In addition, innovations aimed at increasing production will be allowed, if they do not have the detriment of quality.

The Regulatory Council may discard asparagus consignments from plantations in which there has been inadequate use of phytosanitary products that may cause toxicity problems, or from plantations suspected of having received an unbalanced fertilization that may give rise to to losses of morphological characteristics and product quality.

The collection and transport of the product to the processing centers will be carried out with the greatest care, trying to avoid breakage and desiccation of the shoots. In addition, the Regulatory Board will give campaign rules and may determine the collection deadlines and, where appropriate, regulate the plantation regime.

The Council will control the productions by plot for which it will be able to demand to the physical or juridical people integrated in the specific appellation the presentation of their contracts of sale, buyers to which the product is delivered, etc., in order to be able to differentiate the products welcomed from those not covered.

3.2.2. Asparagus for fresh consumption

Asparagus intended for fresh consumption can be classified into two groups depending on the color they present:

- White asparagus

- Purple asparagus in which the yolk and a part of the turion present a pink coloration

The presentation, in addition to the color, must be whole and have a fresh, healthy appearance and smell, and the defects of rottenness or alterations that make them unfit for human consumption will be excluded. They must also be exempt from attacks by rodents, insects or other pests, free from bruises, clean and devoid of foreign matter, drained after washing and devoid of odors and strange flavors.

The cut made in its base will be straight and perpendicular to the longitudinal axis. The shoots will not be hollow, cracked or broken, however, small cracks that may appear after harvesting will be tolerated.

Asparagus for fresh consumption will be classified into three different categories that are:

- Extra category: Asparagus of superior quality and will be well formed and practically straight. Taking into account the normal characteristics of the group to which they belong, they must have the yolk very closed. Very light signs of rust are allowed provided they can be removed by the consumer, with normal peeling. Lignification is not allowed in shoots.
- Category I: Asparagus that must be well formed and of good quality. They may have a certain curvature. Taking into account the group to which they belong they must have the yolk closed. Small rust signals are allowed as long as they can be removed with normal peeling by the consumer. The asparagus that are white do not admit colored buds and yes some pink coloration is allowed in the turion that disappears after the harvest. No lignification is authorized in the shoots.
- Category II: Includes the turions that can not be classified in the higher categories, but must comply with the minimum characteristics previously defined. In comparison with category I, the shoots may appear not so well formed, more curved and with the yolk less closed. Rust signals are allowed whenever they can be eliminated, by the consumer, with the peeling. The yolks of the white asparagus can present a coloration that is not greenish. The shoots may be slightly lignified.

Another classification presented by the asparagus is a function of the length and diameter of the shoot. The length of the shoots will be between 17 and 22 centimeters. The minimum diameter will be 12 millimeters and the calibration will be between 12 and 16 millimeters. From 16 millimeters, the maximum interval will be 8 millimeters in the same container or in the same bundle.

The content of each package or each bundle in the same package must be uniform, with asparagus of the same origin, quality, color group and the same size. The conditioning must be such as to ensure a convenient protection of the product. The materials and papers used inside the containers must be very new, clean and made of materials that can not cause external or internal alterations to the products. The containers will be presented clean, in perfect hygienic-sanitary conditions and free of all foreign bodies.

3.2.3. Canned asparagus

All asparagus intended for preserving should be fresh and tender shoots of *Asparagus officinalis* L; classified in white, green or white with a green or purple head. The producers will be able to deliver turions of up to 22 centimeters in length.

The Regulatory Council will be able to implement qualification and classification norms, that allow to improve the quality or the adaptation to the tastes of the consumer. Asparagus destined to preserve may be presented whole or cut, peeled or not and differentiated with the definitions and trade names established by current legislation, with the exception of category II that will not be covered under the denomination.

Canned asparagus must comply with the general rules for the preparation and sale of canned vegetables, as well as the corresponding specific rules. In any case, the Council may establish additional rules.

The containers will also comply with current regulations on their characteristics and formats. The Regulatory Council may determine what categories, formats, types and sizes are allowed for canned products under the specific denomination.

3.2.4. Registration

The Regulatory Council will carry out the following registers:

- Plantation registration
- Register of fresh traders
- Register of industries

The registration requests will be addressed to the Regulatory Council, accompanying the data, documents and vouchers that, in each case, are required by the provisions and regulations in force, in the forms provided by the Regulatory Council.

The Regulatory Council will deny registrations that do not conform to the precepts of this regulation or to the agreements adopted by the Council on complementary technical conditions that must be met by the asparagus and industries.

Registration in the registers does not exempt the interested parties from the obligation to register in those registers that are generally established.

All those located in the production area planted with varieties of asparagus whose product may be covered by the Specific Denomination and which have requested it in the periods fixed by the Council, shall be registered in the plantation registry. In the case of voluntary withdrawal, and unless there is a change of ownership, at least twelve months must elapse before proceeding to a new registration of the affected plot.

The inscription will include the name of the owner and, if applicable, tenant or owner of the farm and the site, municipal area in which it is located, polygon and cadastral parcels, area, variety or varieties and how many data are necessary for its perfect classification and location. The register of plantations will have plans in which the registered plots will be reflected.

All those located in the production area that manipulate and market asparagus from registered plantations will be registered in the register of fresh traders. In the registration to this register, it will appear the name of the company, location and zone of location and how much data is necessary for the perfect identification and cataloging of the Company. In the event that the Company does not own the premises, this circumstance will be indicated indicating the name of the owner.

In the register of industries will register all those that, located in the production area, are dedicated to the transformation and / or sale in the domestic market or outside of asparagus protected by the specific denomination and that have requested it in the periods fixed by the Regulatory Council. In the inscription the same data will appear as for the registration in the register of fresh traders.

3.2.5. Rights and obligations

Only individuals or legal entities whose plantations are registered in the corresponding registry may produce asparagus that must be protected by the specific denomination. Only this designation of origin can be applied to asparagus from registered plantations that are handled and / or processed according to the standards required by the specifications.

Due to the fact of having registered in the registers, natural or legal persons are obliged to comply with the conditions set out in the specifications and the agreements established by the Regulatory Council.

In the lands occupied by the plantations registered in the Register of Plantations and in their annexed constructions, no asparagus stock may enter or be taken from parcels without the right to the denomination.

In the handling and / or processing facilities registered in the Registries, the introduction, handling, processing, storage and commercialization of fresh or packaged asparagus from zones, localities or plantations not included in the Specific Denomination will be allowed, after notifying the Council Regulator and in such a way that mixing or confusion with the asparagus with the right to Denomination is avoided at all times. The Regulatory Board may give general and / or particular rules for these cases and monitor their correct compliance.

Firms that have registered facilities may only have their asparagus stored in the premises declared in the registration. The signatures registered in the corresponding Registries may use, with the authorization of the Council, the commercial names that they have registered as their property or authorized by their owners. In order for such authorization to take place, they must request it from the Regulatory Board with the vouchers that this requires, expressly stating that they are responsible for everything related to the use of said name in asparagus covered by the Denomination.

The name of the Specific Designation must be prominently displayed on the labels of the containers, in addition to the data that are generally determined in the applicable legislation.

Before putting them into circulation, the labels must be authorized by the Regulatory Council, for the purposes listed in that Regulation. The approval of those labels that for any reason can give rise to confusion in the consumer will be denied. The authorization of a previously granted one may also be annulled, when the circumstances of the firm that owns it have changed, after hearing the signature of the interested party.

Regardless of the type of packaging in which they are issued, the asparagus for consumption shall be provided with a numbered label or counter-label, provided by the Regulatory Council that must be placed before its issuance in accordance with the norms established by the Council. Regulator.

The Regulatory Council will establish the control means it deems appropriate for the conserved traffic without label and / or counter-label. In any case if there is a sale in a stack of covered goods, the seller must communicate the operation in question to the Board.

If said sale is made to a registered manufacturer, it will be mandatory to accompany the merchandise with the counter-labels that correspond to the vendor manufacturer.

If the sale is made to a manufacturer not covered by the name, the Regulatory Council will notify the seller if it should return the corresponding counter-labels to the Council or is authorized to use it in other items for which it has not yet been issued. has provided counter-labels.

The Regulatory Council shall adopt and register an emblem or logo as a symbol of the Specific Denomination. Likewise, the Regulatory Board may make it compulsory that, outside the facilities inscribed and in a prominent place, there be a plaque that refers to this condition.

The Regulatory Board will monitor in each campaign the quantities of asparagus covered by the Denomination issued by each firm registered in the corresponding records, according to the quantities of asparagus from registered plantations, own or foreign and according to stocks and / or acquisitions of asparagus to other signatures registered.

Date: March 2018

Town: Lodosa

Sgd: Jose Javier Nuñez Iñarra

Student: Agri-food & Rural Environment Engineering

PROCESS SYSTEM DESIGN OF A CANNED VEGETABLES INDUSTRY

Public University of Navarre

SCHOOL OF AGRICULTURAL ENGINEERING

Agri-food & Rural Environment Engineering

DOCUMENT 5. MEASUREMENTS AND BUDGET

Author:

Jose Javier Nuñez Iñarra

Director:

Teresa Fernández García

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1.2. Chapter 2. Pepper production line

Pepper production line Cód 0.2

Code	Unit	Description	Quantity
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02.04	Ud	Horno asador junto con elevador desde la cinta transportadora hasta la altura de trabajo	1
02.05	Ud	Transporting band, rectangular shape (8m length x 2m width) 0,35 m of band width	2
02.06	Ud	Cinta transportadora recorrido rectagular (7,3m largox1m ancho) 0,35 m de anchura de banda	2
02.07	Ud	Transporting band for the filling (22,2x0,35m)	22,2
02.08	Ud	Glass bottle closure machine	1
02.09	Ud	Metal can closure machine	1

1.3. Refrigeration installation

Refrigeration installation Cód 0.3

Code	Unit	Description	Quantity
03.01	Ud	Evaporator MKH-NY-1245 (17,7 kW)	1
03.02	Ud	Semi-hermetic compressor 10 GR 50.3X R-134 (8 kW)	1
03.03	Ud	Condenser CBN 29 (28,5 kW)	1
03.04	m	Copper pipes standard bars ND 1,65''	13,65
03.05	m	Copper pipes standard bars ND 0,8''	4,8
03.06	m	Tubería cobre rollos standard ND 1''	16,95
03.07	Ud	elbows 90° ND 1,65''	4
03.08	Ud	elbows 90° ND 1''	2
03.09	Ud	elbows 90° ND 0,8''	1
03.10	Ud	Refrigeration liquid R-134a 1,8 kg (deposit included)	1
03.11	Ud	Accessories	1

1.4. Piping installation

Piping installation Cód 0.4

Code	Unit	Description	Quantity
0.4.01	m	Stainless steel pipe Ø 4"	81,1
0.4.02	m	Stainless steel pipe Ø 3"	26,8
0.4.03	m	Stainless steel pipe Ø 2-1/2"	98,52
0.4.04	m	Stainless steel pipe Ø 2"	85,36
0.4.05	ud	elbows de 90° Ø 4"	8
0.4.06	ud	elbows de 90° Ø 3"	7
0.4.07	ud	elbows de 90° Ø 2-1/2"	7
0.4.08	ud	elbows de 90° Ø 2"	10
0.4.09	ud	Pressure group 15SV03F030T	1

2. Budget

2.1. Chapter 1. Asparagus production line

Asparagus production line Cód 0.1

Code	Unit	Description	Quantity	Price per unit €	Total price €
01.01	Ud	Washing and sorting machine	1	24900	24900
01.02	Ud	Transporting band from the washing and sorting machine to the peeling equipment (5x0,65m)	2	480,35	960,7
01.03	Ud	Peeling machine	2	3425	6850
01.04	Ud	Transporting band from the peeling machine to the blanching 1/2 (2,6x0,3m)	2	115,284	230,568
01.05	Ud	Transporting band for the blanching stage 2/2 (4x0,35m)	1	206,92	206,92
01.06	Ud	Blanching machine 7 m length	1	12840	12840
01.07	Ud	Transporting band for the containers filling (6,8x0,3m)	2	301,512	603,024
01.08	Ud	Cinta transportadora desde llenado de envases hasta cerradora (14,5x0,2)	2	428,62	857,24
01.09	Ud	Transporting band from the containers filling to the closure equipment	1	118,24	118,24
01.10		Government liquid dispenser	1	2350	2350
01.11		Glass bottle closure machine	1	13270	13270
01.12	Ud	Metal can closure machine	1	18540	18540
01.13	Ud	Transporting band from the closure equipment to the autoclave circuit	1	1921	1921
01.14	Ud	Autmatic system of autoclaves	1	12000	12000
01.15	Ud	Autoclaves	2	450000	900000
01.17	Ud	Labelling machine	1	5300	5300
01.19	Ud	Packaging machine (pallets)	1	18700	18700

Total (€)	1019647,692

2.2. Chapter 2. Pepper production line

Pepper production line Cód 0.2

Code	Unit	Description	Quantity	Price per unit €	Total price €
02.01	Ud	Sorter machine for peppers	1	18650	18650
02.02	Ud	Transporting band from the sorter machine to the roast equipment (1,8x1m)	1	266,04	266,04
02.03	Ud	Transporting band from the sorter machine to the roast equipment (1,2x0,6m)	1	106,416	106,416
02.04	Ud	Horno asador junto con elevador desde la cinta transportadora hasta la altura de trabajo	1	7850	7850
02.05	Ud	Transporting band, rectangular shape (8m length x 2m width) 0,35 m of band width	2	1086,33	2172,66
02.06	Ud	Cinta transportadora recorrido rectagular (7,3m largox1m ancho) 0,35 m de anchura de banda	2	941,486	1882,972
02.07	Ud	Transporting band for the filling (22,2x0,35m)	22,2	1148,406	25494,6132
02.08	Ud	Glass bottle closure machine	1	13270	13270
02.09	Ud	Metal can closure machine	1	15360	15360

Total (€)	85052,7012

2.3. Chapter 3. Refrigeration installation

Refrigeration installation Cód 0.3

Code	Unit	Description	Quantity	Price per unit €	Total price €
03.01	Ud	Evaporator MKH-NY-1245 (17,7 kW)	1	2850	2850
03.02	Ud	Semi-hermetic compressor 10 GR 50.3X R-134 (8 kW)	1	3919	3919
03.03	Ud	Condenser CBN 29 (28,5 kW)	1	2122	2122
03.04	m	Copper pipes standard bars ND 1,65''	13,65	4,05	55,2825
03.05	m	Copper pipes standard bars ND 0,8''	4,8	3,1	14,88
03.06	m	Tubería cobre rollos standard ND 1''	16,95	3,5	59,325
03.07	Ud	elbows 90° ND 1,65''	4	6,25	25
03.08	Ud	elbows 90° ND 1''	2	3,15	6,3
03.09	Ud	elbows 90° ND 0,8''	1	2,55	2,55
03.10	Ud	Refrigeration liquid R-134a 1,8 kg (deposit included)	1	69,22	69,22
03.11	Ud	Accessories	1	1603,92	1603,92

Total (€)	10727,47891

2.4. Chapter 4. Piping installation

Piping installation Cód 0.4

Code	Unit	Description	Quantity	Price per unit €	Total price €
0.4.01	m	Stainless steel pipe Ø 4''	81,1	80,25	6508,275
0.4.02	m	Stainless steel pipe Ø 3''	26,8	76,55	2051,54
0.4.03	m	Stainless steel pipe Ø 2-1/2''	98,52	72,3	7122,996
0.4.04	m	Stainless steel pipe Ø 2''	85,36	68,75	5868,5
0.4.05	ud	elbows de 90° Ø 4''	8	20,5	164
0.4.06	ud	elbows de 90° Ø 3''	7	20,5	143,5
0.4.07	ud	elbows de 90° Ø 2-1/2''	7	14,75	103,25
0.4.08	ud	elbows de 90° Ø 2''	10	14,75	147,5
0.4.09	ud	Pressure group 15SV03F030T	1	6449	6449

total (€)	28558,561

3. Summary

Summary (€)		
Production lines	Pepper	85052,70
	Asparagus	1019647,69
Installations	Refrigeration	10727,48
	Piping	28558,56
Budget (€)		1143986,43
I.V.A. (€)		240237,15
General expenses (€)		148718,24
Benefits (€)		68639,19
Project execution budget (€)		1601581,01

Taken into account the measurements and budget presented above, the final Budget for the Project ascends to ONE MILLION SIX HUNDRED ONE THOUSAND FIVE HUNDRED EIGHTY ONE EUROS AND ONE CENT.

Date: March 2018

Town: Lodosa

Sgd: Jose Javier Nuñez Iñarra

Student: Agri-food & Rural Environment Engineering